PROJECT HYAC II

Progress Report No. 3

31 July 1958 - 31 August 1958

SDR-9103-2

TABLE OF CONTENTS

HYAC II

PROGRESS REPORT NO. 3

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1.0 INTRODUCTION

Significant progress has been made in the over-all project. On 15 August, approval was obtained from the prime and the customer for the purchase of a quantity of special test equipment for the project. Within two days, virtually all of the long lead-time items had been ordered. Vendor delivery dates vary with the last item of equipment scheduled for delivery on November 15. The total construction costs for a building to house the equipment were not approved and a joint arrangement has been worked out whereby ITEK Corporation will assume the cost of a general purpose building with the customer assuming the cost of any special installation requirements peculiar to the equipment to be housed, and any additional costs incurred because of security requirements.

The American Research combination altitude-humidity-temperature environmental chamber ordered in June was delivered on schedule on 5 September at ITEK, Waltham. A temporary wooden enclosure was built to accommodate the chamber during construction of the remainder of the building. This instrument will be completely calibrated and ready for immediate use on project tests by 12 September.

For vibration testing, a Calidyne shaker of 5,000 lbs. force capacity was purchased. Approval of the prime was obtained for our equipment requests in the vibration testing field except for those components required for random vibration.

A Barry shock machine was ordered with the understanding that a waiver on the General Environmental Specification on pulse shape tolerances from 5 per cent to 10 per cent was acceptable to the prime. This machine is scheduled to be delivered on November 15.

The ITEK test facility at Waltham, when completed, will have the capability for exclusive testing on the HYAC II project to meet the General Environmental Specifications on altitude, temperature, humidity, vibration, and shock, in a completely secure area.

Explosion testing is currently being planned, using a breadboard mock-up in an outside facility. Arrangements are now being made for acceleration testing of the complete camera. For security reasons, dummy parts may be used so that the unit will not be recognizable or its purpose deduced.

In addition to the environmental test equipment purchased for installation at the Waltham facility, a dynamic simulator is being built by ITEK for use on this project. It also will be installed in the secure area at the Waltham plant.

An Electronic Associates analog computer was ordered with a three-month delivery date quoted. The most recent information from Electronic Associates indicates that delivery might well be accomplished much earlier than November 15, i.e., on or about the first week of October.

A folding endurance testing machine, a Scott tensile strength tester, and a small temperature and humidity chamber of about 4 cubic feet capacity will be used in film testing at ITEK. Delivery of these items will be accomplished within the next reporting period, and testing will begin as soon as the equipment is available. The small vacuum chamber requested is now in use. Special instrumentation for the ITEK dynamic simulator will be ordered and delivery accomplished according to schedule. The static charge electronic VTVM has been ordered and will be used for film static tests at altitude. The prime advised that miscellaneous instrumentation for tests do not require the same formal approval as the other items.and,per verbal instruction, we are purchasing these instruments directly on the contract.

Present schedules call for building completion by 15 November. A document based on "HYAC II Proposed Test Program" (30 July 1958) but revised and more detailed, is scheduled to be prepared by 1 October. This will include the acceptance test specifications and acceptance test procedures for the deliverable units.

2.0 PHOTOGRAPHIC SUBSYSTEM

During the last reporting period, a decision was made to drop the requirement for momentum balancing of the supply spool. This decision was based on the latest inputs on the control system parameters. It has been determined that deletion of this will produce a negligible effect due to yaw attitude rates caused by gyroscopic coupling, and that the roll rate due to the torque reaction caused by starting of the supply spool can be damped out by the external control system. It should be pointed out, however, that during the time of this transient, rates of the order of 1/2 degree per second will exist and cause significant blur. Our estimates after discussions with the prime on the control system characteristics are that this transient should be damped out in about a minute. Both static balancing and momentum balancing of the stovepipe assembly are still required and will be incorporated in the camera design. This is due to the fact that the unbalanced momentum would cause significant roll and yaw rates because the period of this excitation is short relative to the control system time constant. Effectively, the control system would not be able to react fast enough so that momentum balancing is required in this area. Computer studies are planned to indicate the magnitude of these effects.

Because of the elimination of momentum balance on the supply spool and the general progress in the weight reduction area, Fairchild has now agreed that they will furnish a camera weighing not more than 65 pounds with minimum weight as a design objective. This will be incorporated in the definitive contract work statement.

A decision has apparently been made by the prime that the film capacity initially will be halved to twenty pounds. However, the design of the camera will still be for a forty-pound film capacity.

a. As of 31 August, 90 per cent of the total job was released by Fairchild for the camera and cassette.

b. A thermal mock-up was delivered to the prime per schedule on 15 August (see Fig. 1 and 2).

c. A film spool design was released and a decision made to fabricate a total of 115 supply spools to be shipped to ITEK for film spooling according to the following schedule:

   Fifteen on 27 August

   Twenty on 5 September

   Forty on 12 September

   Forty on 19 September

   The first shipment of fifteen has been shipped to the supplier for spooling. Twenty are on hand at ITEK with additional deliveries anticipated according to schedule.

Cassette interface agreements between the companies involved have been reached which appear satisfactory. ITEK has a requirement in its test program for a sufficient amount of the cassette-to-vehicle tie-in structure to have a complete camera. Appropriate arrangements for furnishing either the actual

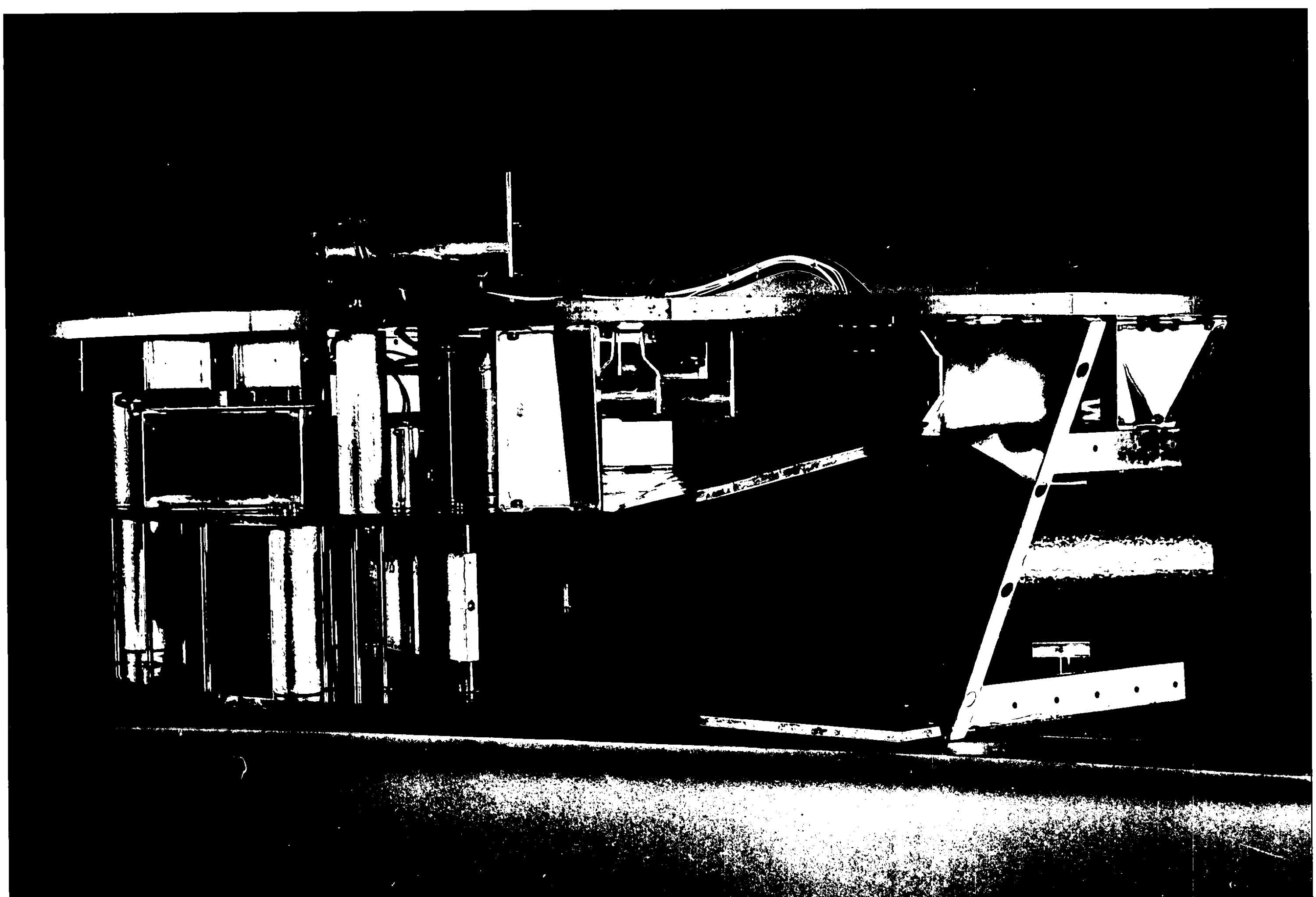

FIG. 1 CAMERA THERMAL MOCK-UP

hardware or the drawings for in-house fabrication will be required very soon. In addition, a conical section is also required from the prime. It has been agreed during this reporting period that cassettes will be provided to our associates for their test program which is scheduled to begin in October. ITEK is making plans to provide exposed but not processed film (probably using resolution targets as images) to be placed in these cassettes. It is desired that one of ITEK's field service personnel and one of Fairchild's engineers participate in this test effort. We would like the unprocessed film returned to ITEK for processing and environmental evaluation. Fairchild is proceeding to fabricate the required quantity of cassettes for delivery at the earliest possible date.

As is our practice, FCIC's report is enclosed as presented. There are, however, several points in the report which require clarification and/or expansion.

The problem of film over beaded rollers is a subject of study at our Physcial Research Laboratory, and a report of tests being conducted is contained herein.

The problem of a permanent set in the film is one of concern, if it will cause a film break. There is no indication at this time of the length of time it will take for a damaging set to occur. As reported elsewhere, a test was run during this period simulating an operational cycle wherein the film was threaded through a film drive mock-up containing two (2) 90° rollers and soaked for 14 hours at a vacuum approximating 200,000 ft. Subsequent operation of the film drive was successful.

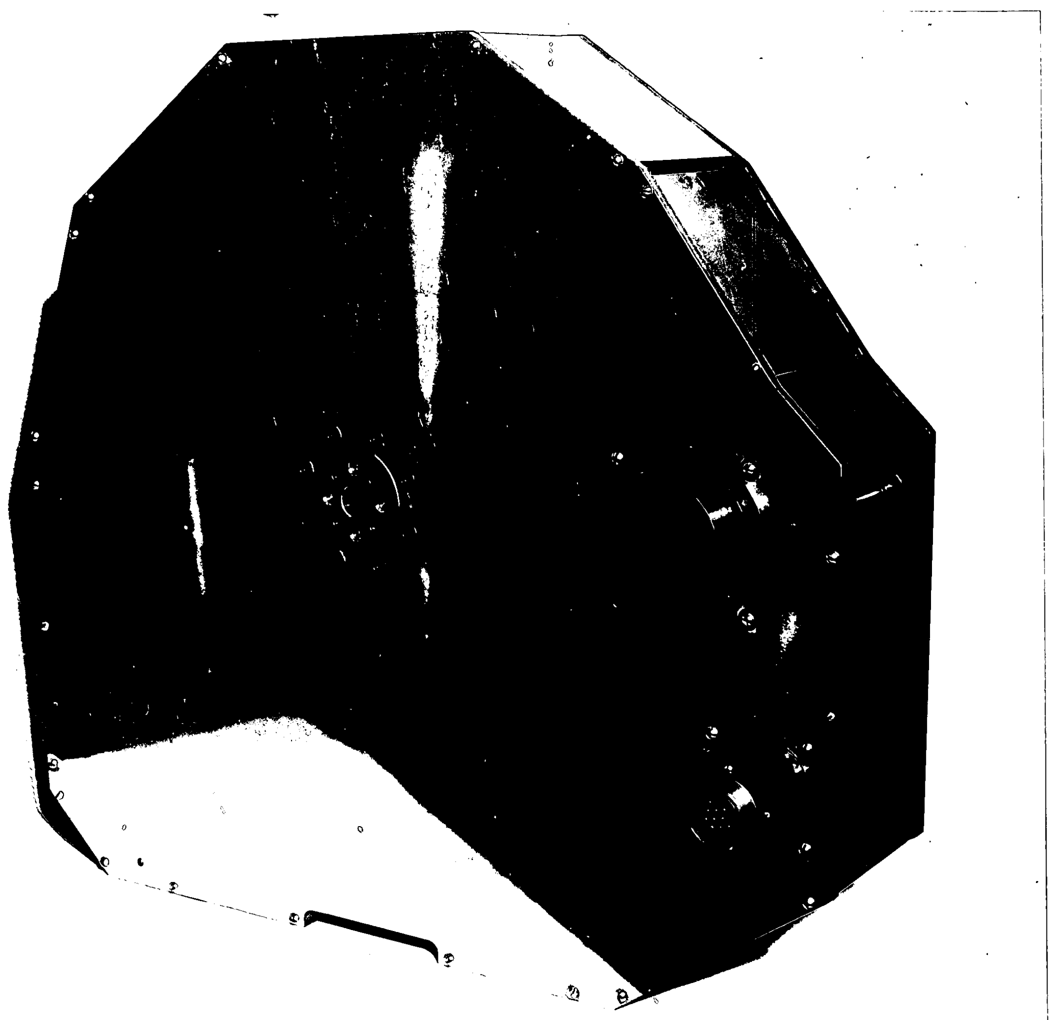

FIG. 2 CASSETTE THERMAL MOCK - UP

With the installation of the altitude chamber at our HYAC Test Facility at Waltham, it is expected that simulated operational flights will be programmed as soon as the actual film drive breadboard is made available.

FCIC is investigating film creep during non-photographic periods of mission. At present, it appears that 43 ft. of film/hour will be exposed.

Enclosure I
2 September 1958

The following sections 2.1,2.2, and 2.3 were submitted by FCIC.

HYAC II

Progress Report No. 3

1 August 1958 thru 31 August 1958

General

During this reporting period, the program has experienced several design changes due to additional customer inputs in conjunction with breadboard debugging findings. As a result, the design and detailing effort has suffered a three (3) week set-back from the original release date schedule. To date approximately ninety (90) percent of the total job has been released to the shop. The operating schedule has been revised such that the delay in shop releases will be compensated for during the fabrication and laboratory phases of the program. Based on the initial proposal and specifications, the intention is to make deliveries in accordance with the work statement. The overall estimated percentage of completion of the program is approximately 20%.

A re-evaluation of the program is under way because of customer requested changes to the original Fairchild proposal. There were two significant areas of changes requested. The first was establishing the camera weight as a firm requirement in lieu of a design objective. The second was the requirement for complete environmental qualification prior to initial shipments in lieu of conditional acceptance of the initial units. This re-evaluation will also consider changes of tasks that have occurred on the program since the last submitted proposal.

2.1 Camera Detailed Progress

A. Breadboard Testing

1. Film Handling Breadboard
(See Figures 3, 4, & 5)

An up-dating of this breadboard to represent, closely, the final design released, has been completed and is presently under test. Test results to date indicate unreliability in handling the customer specified thin-based gelatin-backed film over the skewed rollers. The sliding action of the film backing over the teflon or

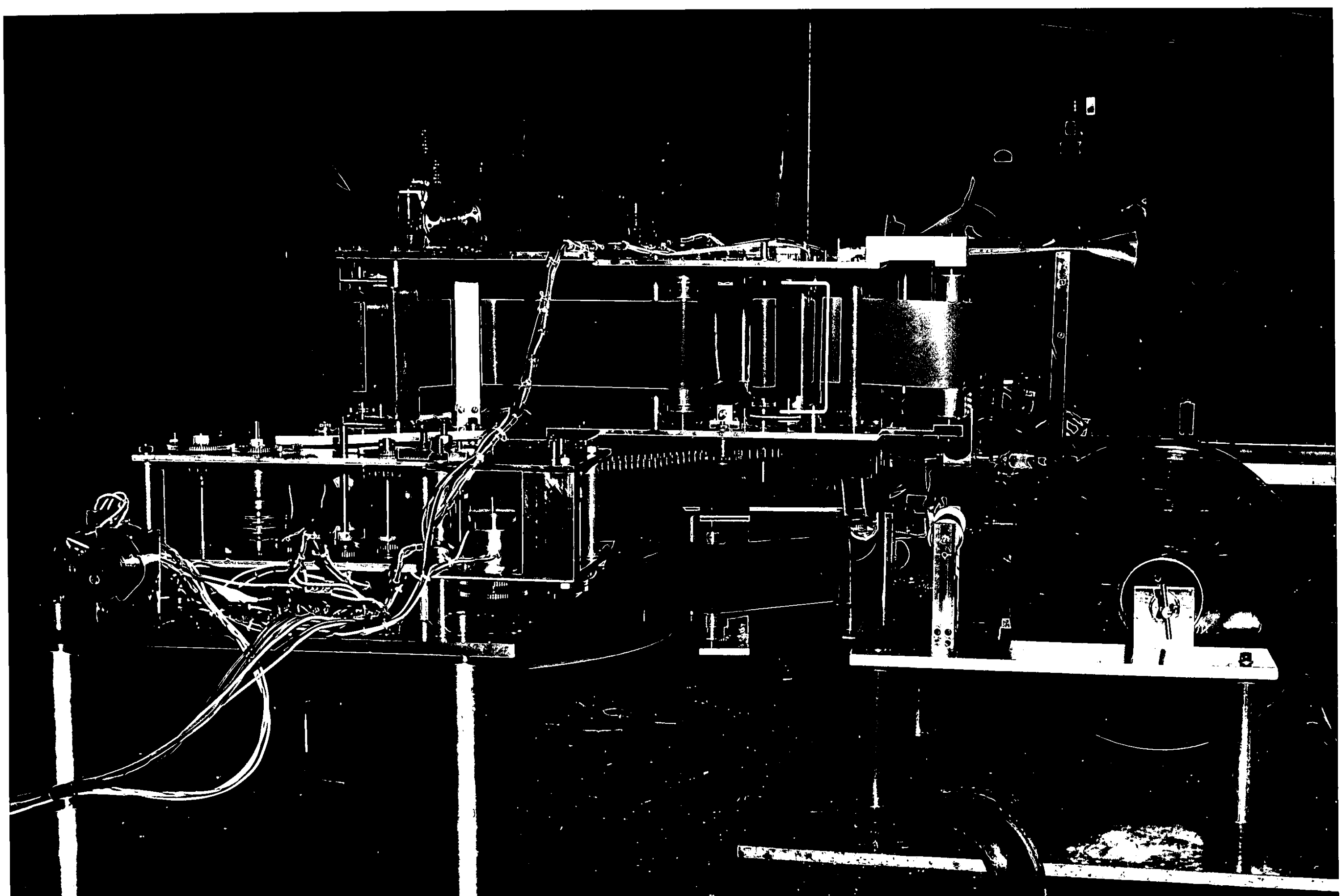

FIG. 3 CAMERA FILM HANDLING BREADBOARD

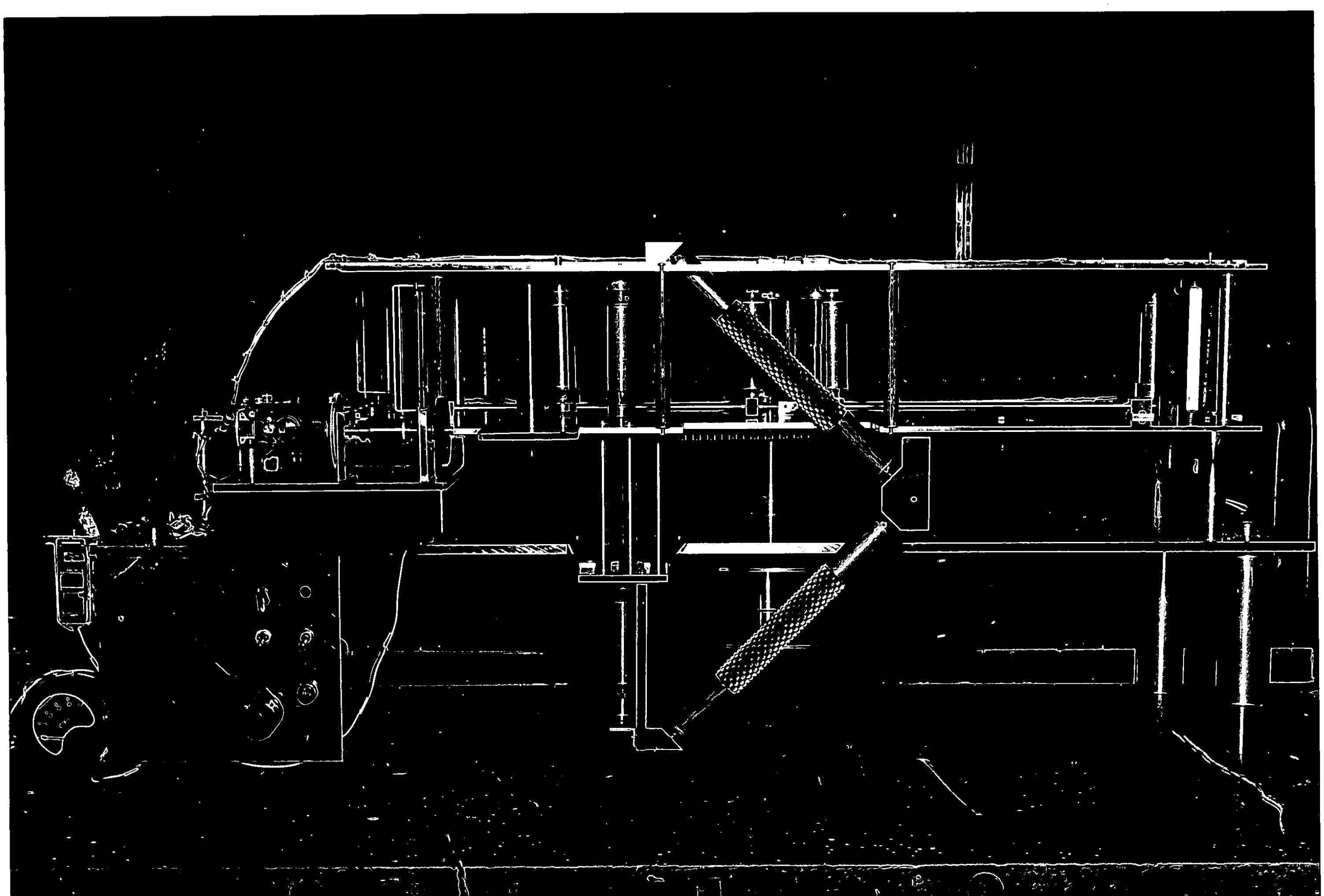

FIG. 4 FILM HANDLING BREADBOARD (OTHER VIEW)

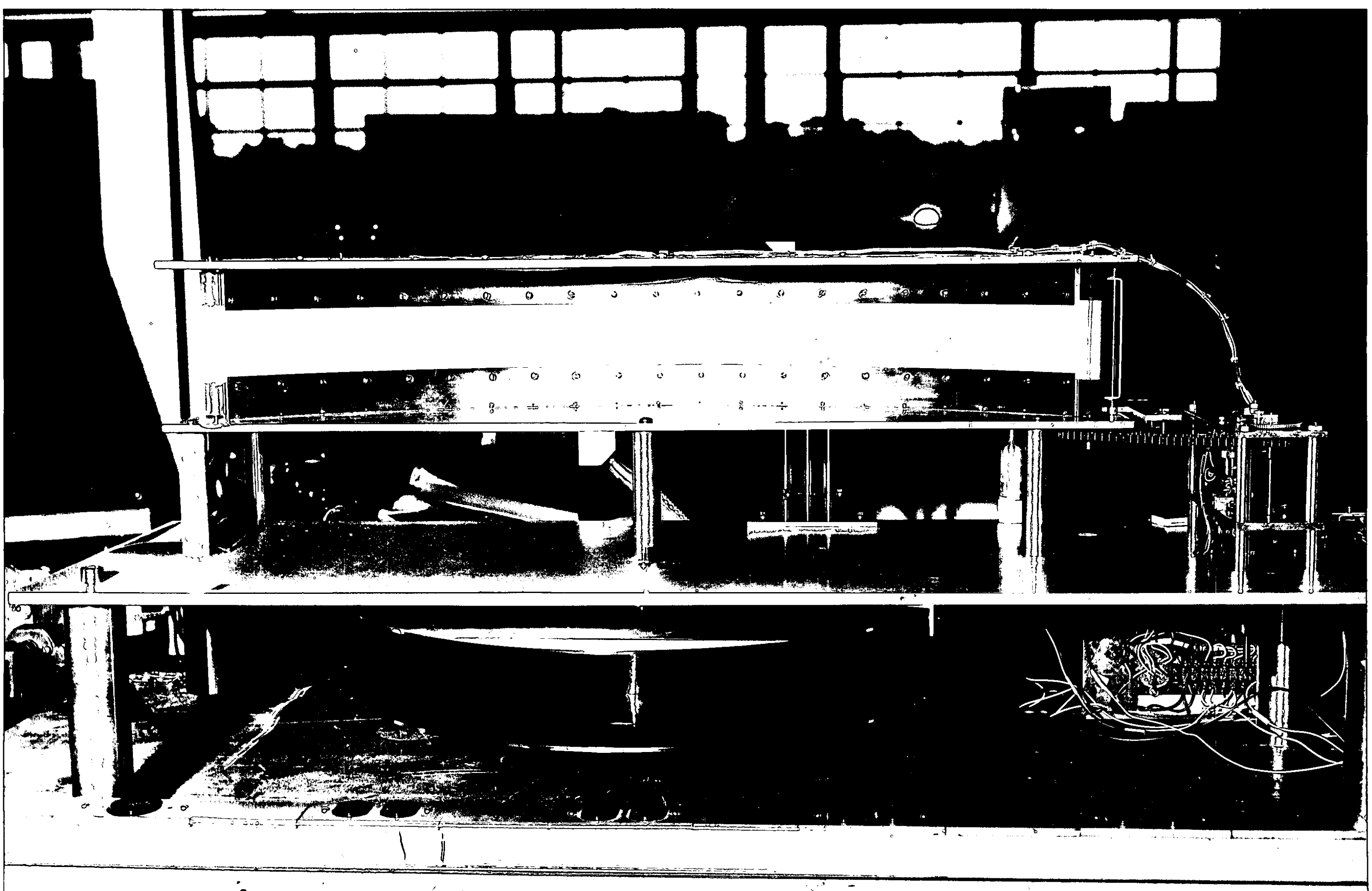

FIG. 5 FOCAL PLANE ARC - FILM HANDLING BREADBOARD

stainless steel skewed rollers is unpredictable. It appears that only the beaded skewed rollers offer the potential reliability demanded in film handling but with the present dis-advantage of producing undesirable pressure marks. A re-design of the present beaded roller is underway in an effort to reduce the pressure marking to within acceptable limits.

Also, in conjunction with the film handling problem, the customer has made efforts to acquire mylar or cronar based film. To date, these efforts have been unsuccessful.

An additional problem has been presented to us by the customer relative to the film. Indications are that if this film is stationary under tension, around rollers, under the operational environment, for anything beyond several minutes, a permanent set will take place causing the film to break upon starting up. Fairchild has been requested to make a feasibility study on allowing the film to creep slowly and/or imtermittantly during the normal off periods of its operational cycles. This study shall indicate how the problem can solved and what affect, introducing this change into the present design, will have on delivery of the final equipment.

2. Lens Drive Breadboard
(See Fig. 6)

Because of the velocity ripple and resulting banding generated by the original lens drive breadboard, it was decided to modify the design approach somewhat. The new design consists of a closed loop, double drum tape drive, driven bi-directionally by a single Saginaw screw. This approach permits a heavy, loaded tape with no load on the Saginaw or input drive members. It is felt that this drive will reduce dynamic compliances to within acceptable limits. This breadboard will be ready for tests starting the first week in September 1958.

A straight gear drive in presently in design for back-up breadboarding in the event it is necessary. This breadboard will be tested and results reported as to smoothness and accuracy even in the event it is never adopted into the final camera design.

3. Frequency, Timing and Fiducial Recording Systems

Tests have been completed on various lamps and pulsing supplies to secure optimum quality and reliability of data exposures over the range of film emulsion speeds. The time recording lamp pulsing supply has been designed to be synchronized with the movement of the "Digitote" wheels and the nadir pulse such that no wheel motion will exist during exposure. The lamp pulsing supply package for these three (3) data recording systems has been designed and detailed and

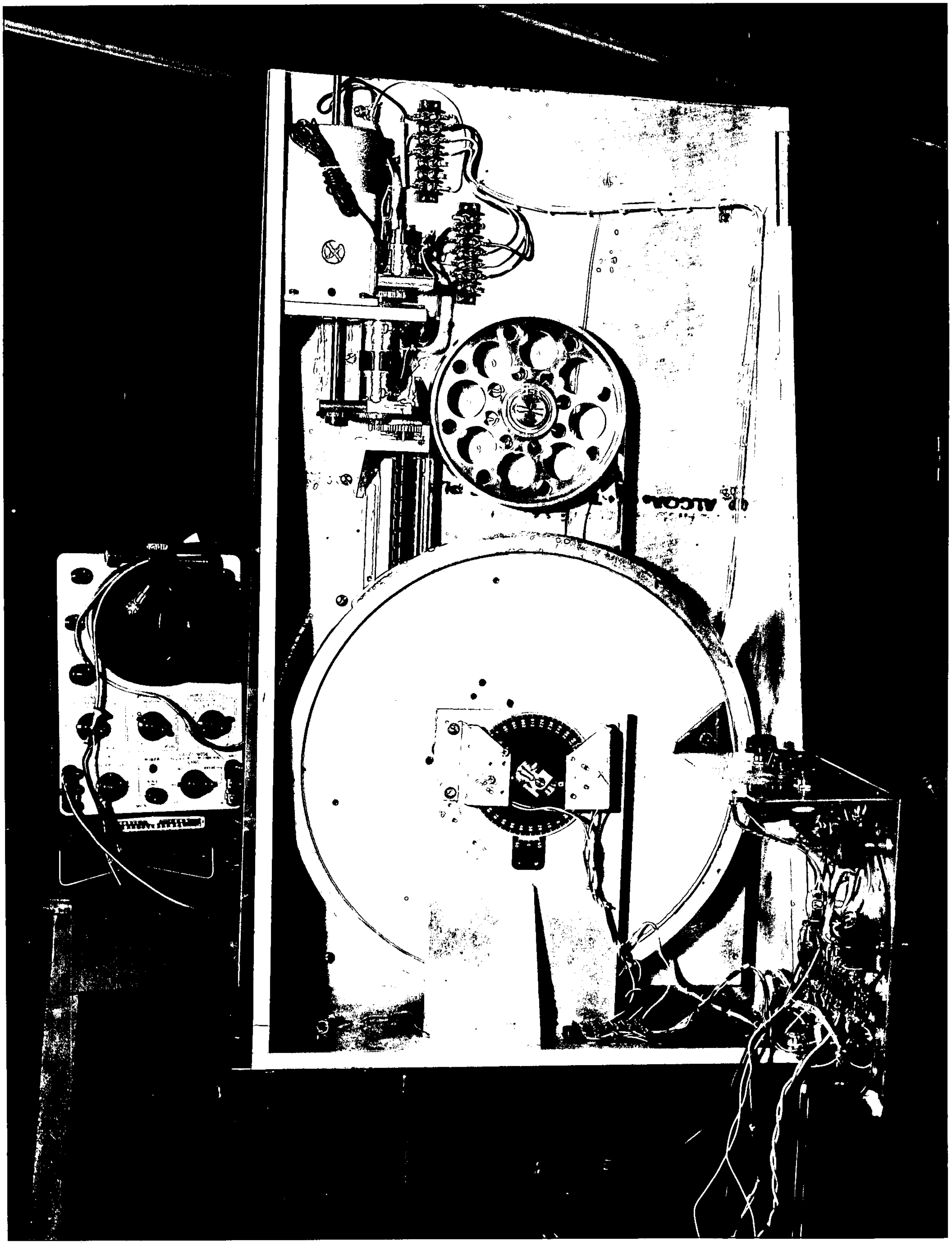

FIG. 6 LENS DRIVE BREADBOARD

will be released for fabrication early in the month of September 1958.

4. Scan Servo System

A velocity servo system based on motor armature voltage control from series power transistors has been selected for the scan rate control. A motor design of reduced voltage rating has been selected to match the characteristics of the transistor supply. Heat runs are being made on various heat sink arrangements to dissipate the heat generated in the transistors.

The accelerating control package to program start-up for slow acceleration of the servo drive has been successfully tested.

The entire scan servo system has been designed, detailed and released for fabrication.

5. Electrical Schematics

The preliminary control schematic is being revised showing up-to-date circuitry and location of internal and outgoing circuit connectors. A harnessing diagram is also being prepared and will be released approximately by the middle of September 1958.

6. Curved Platen Breadboard

Although early indications of the aluminum - lockfoam platen fabrication looked very promising, recent results indicated the need for machining. The machining problem proved that this construction was not rigid enough to maintain the final dimentional stability required. Also in changing from aluminum to titanium because of the temperature expansion problem proved to create a springier platen with even more difficult machining problems. In addition, the accepted process for blackening the platen surface (titanium) requires temperature up to 400°F which will warp the finished platen.

Present effort is directed toward a honeycomb platen with side honeycomb stiffening plates. Also investigations into a low temperature blackening process for titanium is under way.

7. Thermal Investigation

The customer has requested that Fairchild investigate the feasibility of gold plating the titanium honeycomb plates and highly polishing the main aluminum honeycomb plate. This study is to indicate the affect on our schedule in the event of having to introduce this item as an additional task. This investigation is underway and results will be reported to the customer approximately by Mid-September 1958. The presently designed-in philosophy as related to the thermal problem is to provide good conduction of all the heat generating sources to the main plates as heat sinks. This approach avoids hot spots and over-heating of components.

8. Horizon Recording System

The horizon systems are basically two separate, complete cameras with focal plane, format frame, lens cone and lens and shutter assemblies. All components of these horizon cameras have been selected and performance tested.

a. Lens - After evaluation of the 4 inch Artar lens proved unsatisfactory, the C.P. Goerz American 90mm f/6.8 Aero-tar lens with a K2 filter was selected and tested. The Aero-tar gave distortion values less than 10 microns over the format and specified minimum resolution on SO-1213 of 60 lines/mm with peak values to 122 lines/mm at 7.5°. Based on these performance figures, the Aero-tar lens with filter was decided on for the optics of the horizon recording cameras.

b. Shutter - Life tests were run on a standard, light duty, Wollensak Alphax shutter with unsatisfactory results. Next, a heavy duty #1 Alphax shutter (Wollensak) with speical tolerances was procured and tested. This shutter was satisfactorily tested up to 25,000 cycles at its maximum operating rate. Based on meeting the life tests, and since this is the only available shutter with single motion trip and cock (permitting two-unit synchronization), this shutter was decided upon. The shutter has a nominal exposure time of 1/200 second with a corresponding actual total open time of approximately 1/100 second. Diaphragm control will be used, set manually, for proper exposure for the different film speeds specified.

c. Lens Cone - The lens cone is designed to mount on three (3) points with one point used for a pivot centered on the film plane. The design permits holding the film by pressure plate against the format frame which incorporates four (4) fiducials illuminated by subminiature lamps.

Enclosure I

Relative to the horizon recording cameras, the customer has requested that FCI design and fabricate the optical alighment and check fixture for the horizon cameras. This task will be included in the re-evaluation of the proposal.

9. Digitote Recordings -

Illumination of the Digitote for recording with a lens had to be accomplished from scratch since the Digitote illumination was only for viewing and completely inadequate for photographic recording.

Breadboard tests were run with two (2) emulsions using a newly designed housing over the numbers incorporating reflective illumination and masking. Four (4) ACM #21L subminiature lamps flashed at approximately 25 milliseconds duration wereincorporated into the housing. Tests were run varying the luminous output by switching resistance values in the lamp circuits. A Wollensak triplet f/2.5 lens with 1 inch focal length was selected for availability and small size and weight. Good recordings were obtained with this system and final design for releases have been instituted. The release for this package will be compatible with the overall program.

B. Component Tests

1. Camera Structure - The basic structual plate was re-designed with 1/8 x .001 aluminum honeycomb and a larger insert and retested under the vibration requirement. This plate passed the tests successfully.

2. Servo Amplifier - Altitude tests and heat sink tests are in process for this unit. Results to date look quite promising using the main plate as a heat sink for the power transistors.

3. Horizon Optics - Altitude tests are under way to determine the effect on focal length setting for the systems.

C. Future Effort

The major effort will be to solve the film handling problem and evaluation of the modified lens drive breadboard. Concurrently, a maximum effort will be directed toward expediting the releases through the fabrication phase of the program to make up lost time in order to adhere to the existing schedules.

Component testing will be accelerated to assure maximum reliability prior to completion of the first cameras.

The complete proposal re-evaluation will be completed and submitted to the customer by approximately mid-September 1958.

2.2 Cassette Detailed Progress

A. Breadboards
(See Figures 7 & 8)
1. Film Take-Up Breadboard

A jack shaft drive arrangement with straight bevel gears was selected in lieu of the Gilmer belt or flexible shaft. This drive was designed, fabricated and tested. The test results were satisfactory and a refined spiral bevel gear arrangement will be used in the final units. Upon completion of the first spiral bevel gear drive, further tests will be conducted to assure its reliability.

B. Design Evaluation
(See Figure 9)

A cassette, incorporating the design changes brought about by changes in requirements, has been fabricated and subjected to vibration, acceleration and shock tests with a full spool of film, for the purpose of engineering evaluation. The results indicated that the final design is satisfactory. Accordingly, the complete cassettes will be released for fabrication.

To date approximately 90% of the cassette components for 10 units have been released for fabrication. Within the next few days, one cassette containing all components will be completed and subjected to the environmental tests. This re-test will be for the purpose of qualifying the film footage indicator and anti-back-up mechanism in addition to re-assuring the rest of the design capabilities.

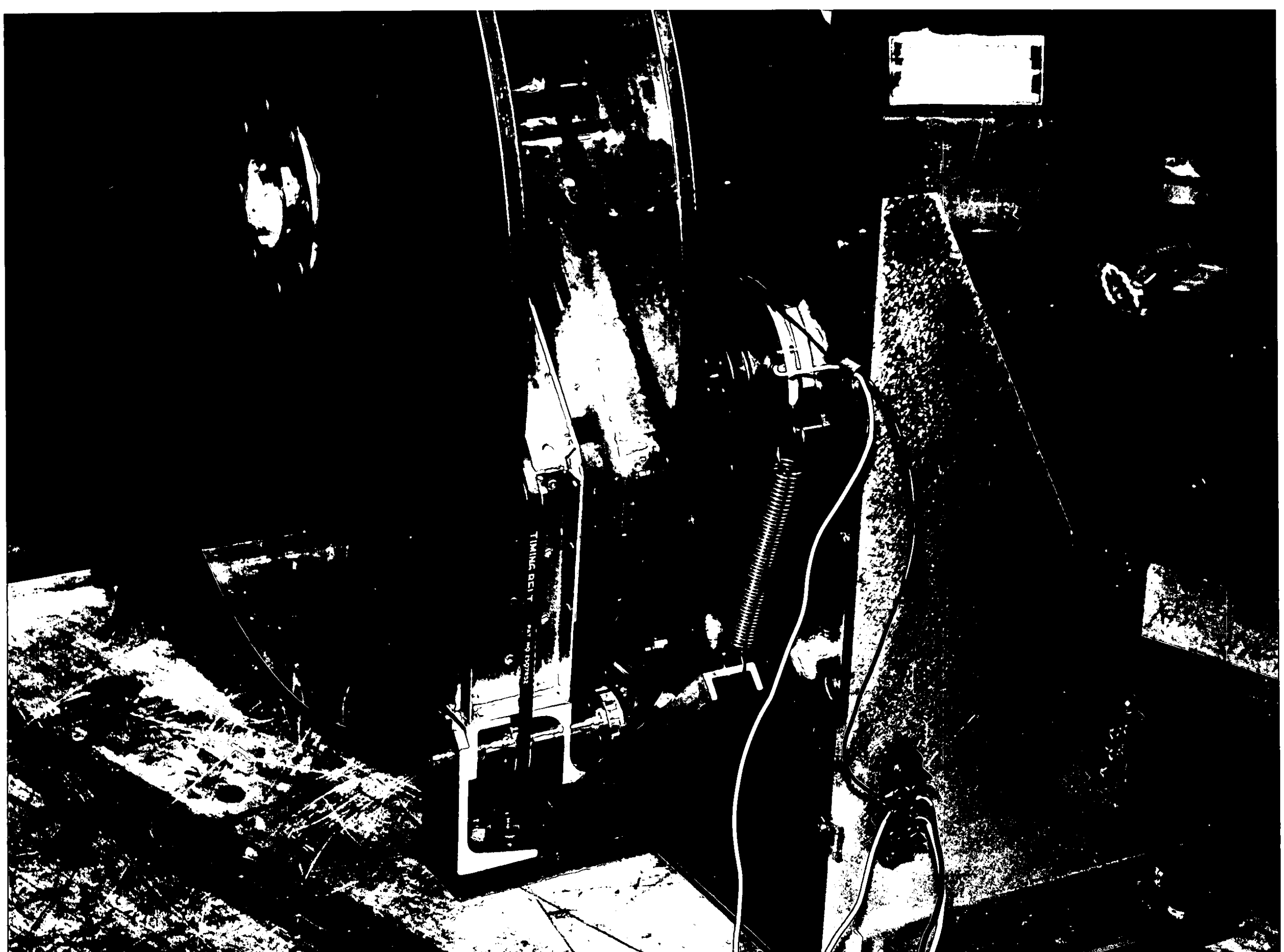

FIG. 7 FILM TAKEUP SPOOL BREADBOARD

FIG. 8 CASSETTE FILM TAKEUP DRIVE BREADBOARD

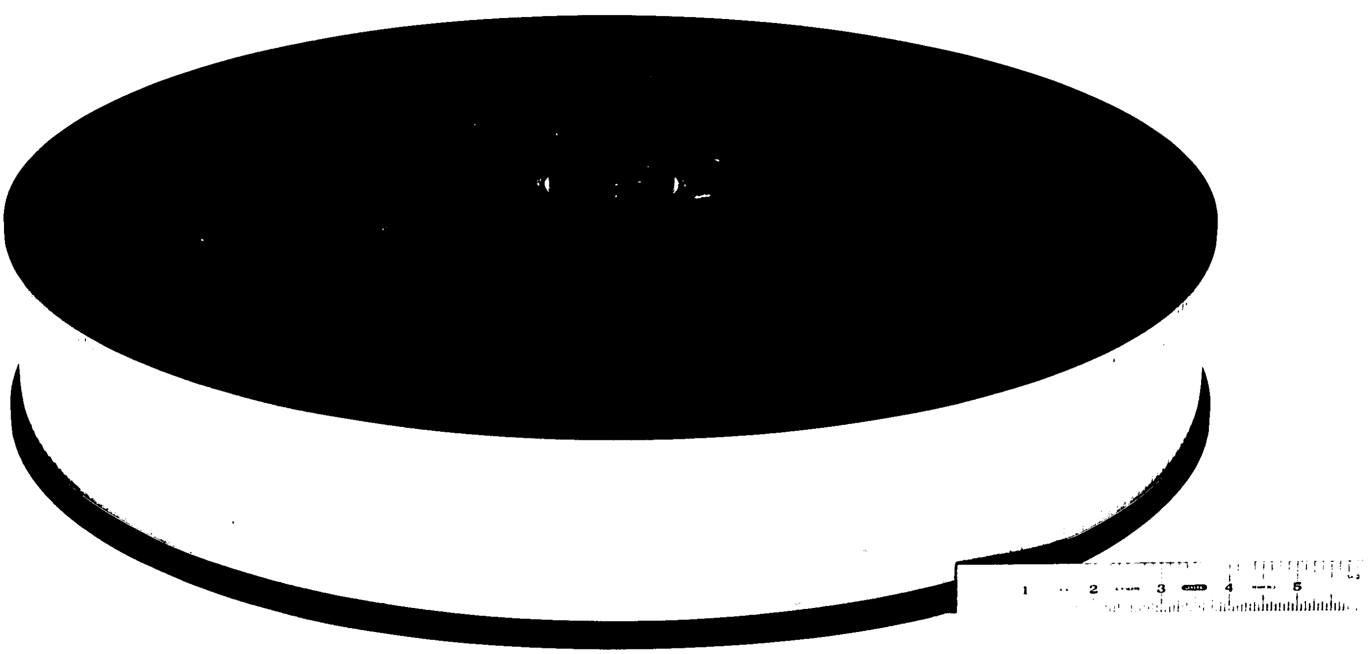

FIG. 9 TAKEUP SPOOL - FINAL DESIGN

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2.3 Consoles and Test Fixtures Detailed Progress (See Figure 10)

A. Fixtures

Camera Holding, Camera Test and Camera-Cassette Test fixtures have been completely designed with quantities of each of the three types of fixtures established. The camera holding fixture has been released for fabrication; this represents 20% of the total effort in this area. The complete releases for the remaining fixtures will take place during the first week in September 1958.

B. FCIC Test Equipment

The simulated programmer, test panel and simulated vehicle clock (time totalizer) have been fully released for fabrication. The fabrication effort is approximately 20% complete with the task on schedule. Preliminary plans for the Tower House has been completed. The altitude test chamber has been received and put into operation in the laboratory during the last week in August 1958.

C. Deliverable Test Consoles

All long lead items such as recorders, power supplies and console cabinets have been ordered. The design is continuing on freezing the control panel and establishing needed test points and interwiring. Design task is approximately 80% complete. Anticipated freeze of the control panel will be during the first week of September. Transit cases have been released for procurement.

D. Future Effort

Fabrication will continue and the job completely released. This effort is on schedule with no technical problems.

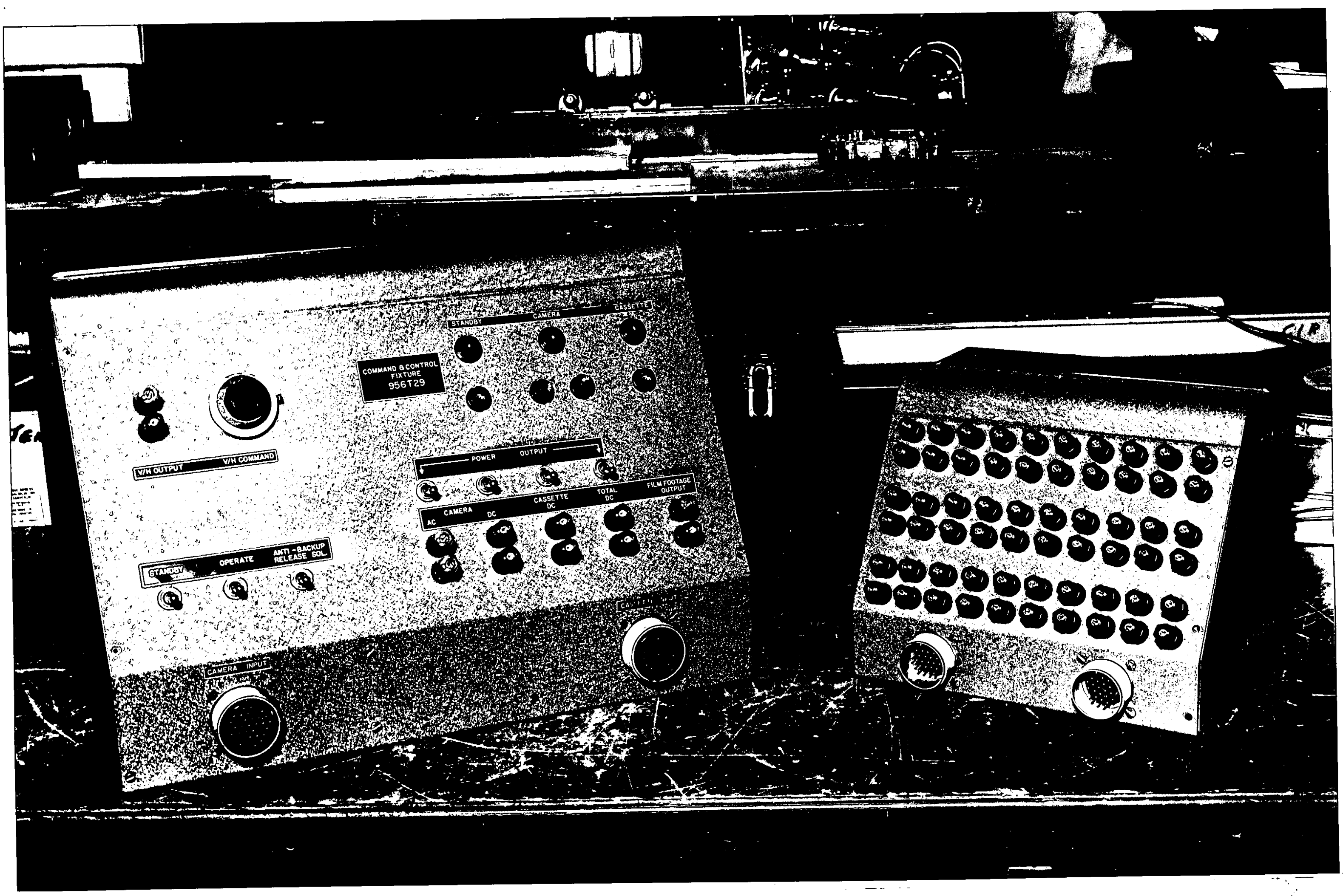

FIG. 10 TEST AND CHECKOUT FIXTURE

2.4 LENS ASSEMBLY

2.4.1 OPTICS

The first HYAC II 24-inch f/5 lens has been fabricated. The first assembled unit, partially asperized, was put in the test cell on 3 Sept. (See Figure 11, LENS FABRICATION FIXTURE FOR TESTING). Figure 12 shows a rough polishing operation on one of the elements of the first unit. Figure 13 shows the final aspherizing operation. Figure 14 shows the first HYAC II lens. The larger element is the first element. Note that there are four elements in this modified Tessar design.

Preliminary results following additional aspherizing indicate a lens resolution of 260 lines per millimeter on axis. The first lens/film resolution checks have been completed, indicating an on-axis resolution of 100 lines per millimeter (See Figure 15). Our optical personnel are working to a specification of 125 lines per millimeter lens/film combination which is close to the theoretical limit of the combination and they are quite confident of achieving a minimum of 85 lines per millimeter over the field, and hopeful of perhaps achieving in the neighborhood of 115 lines per millimeter. The original preliminary design study was conducted with a lens/film resolution of approximately 90 lines per millimeter.

The 15 September delivery date of the lens to Fairchild, at this writing, will slip approximately one week. Additional aspherizing is necessary to obtain the highest resolution possible. This time taken on the first lens will not affect production delivery. It will establish, for the opticians, a quality guide.

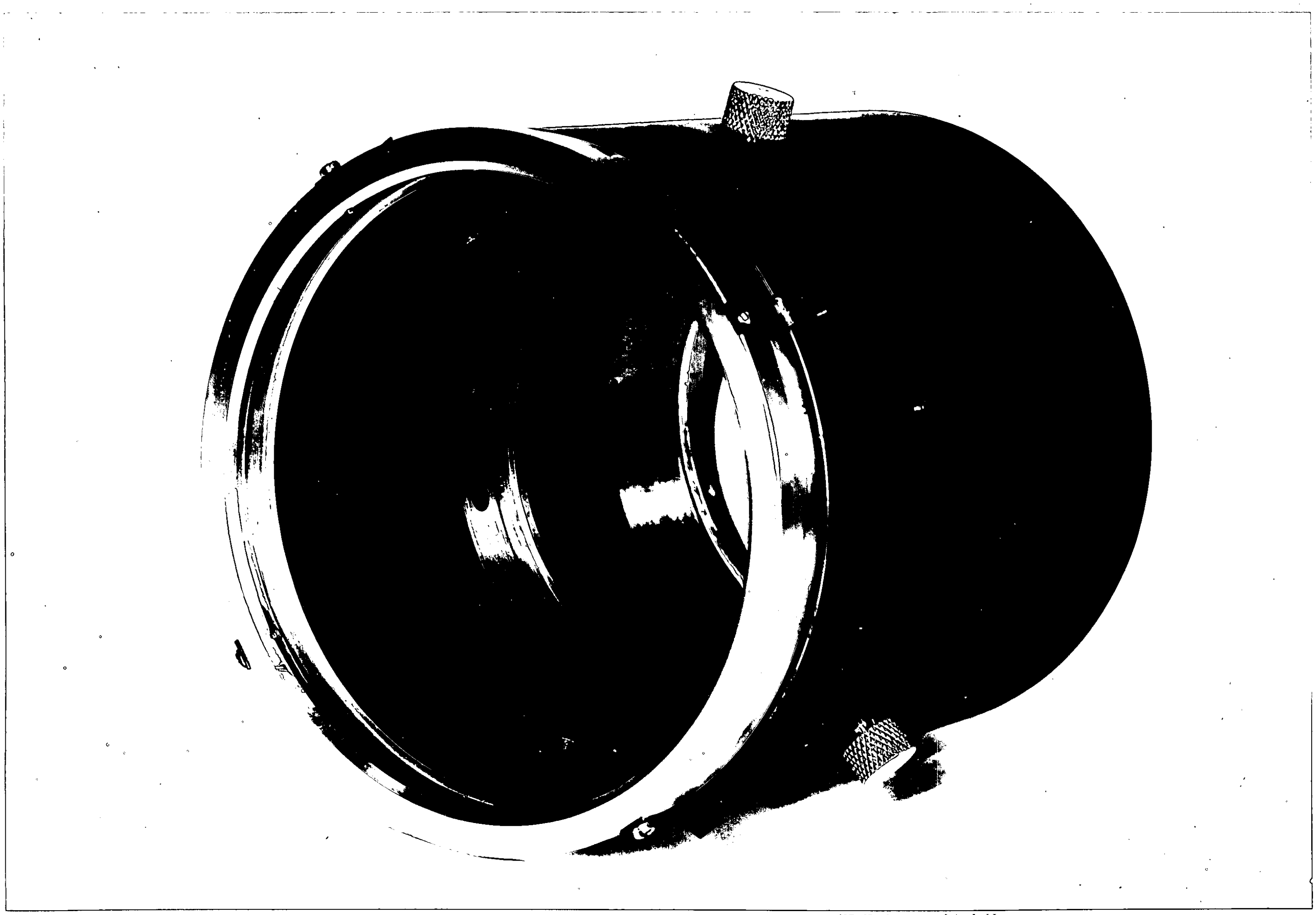

FIG. 11 LENS FABRICATION FIXTURE

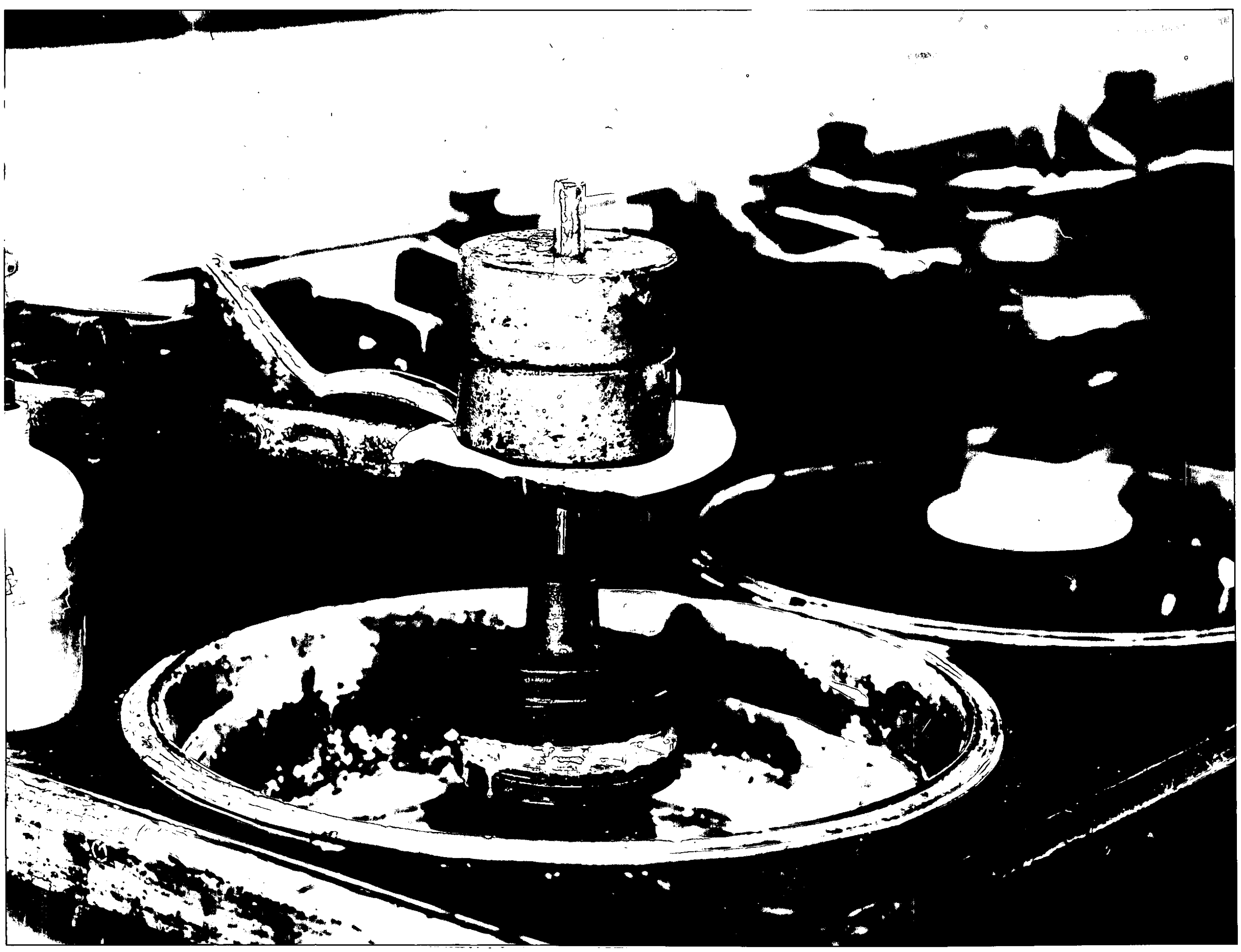

FIG. 12 LENS FABRICATION - ROUGH POLISHING OPERATION

FIG. 13 LENS FABRICATION - ASPHERIZING

FIG. 14 HYAC II LENS ELEMENTS

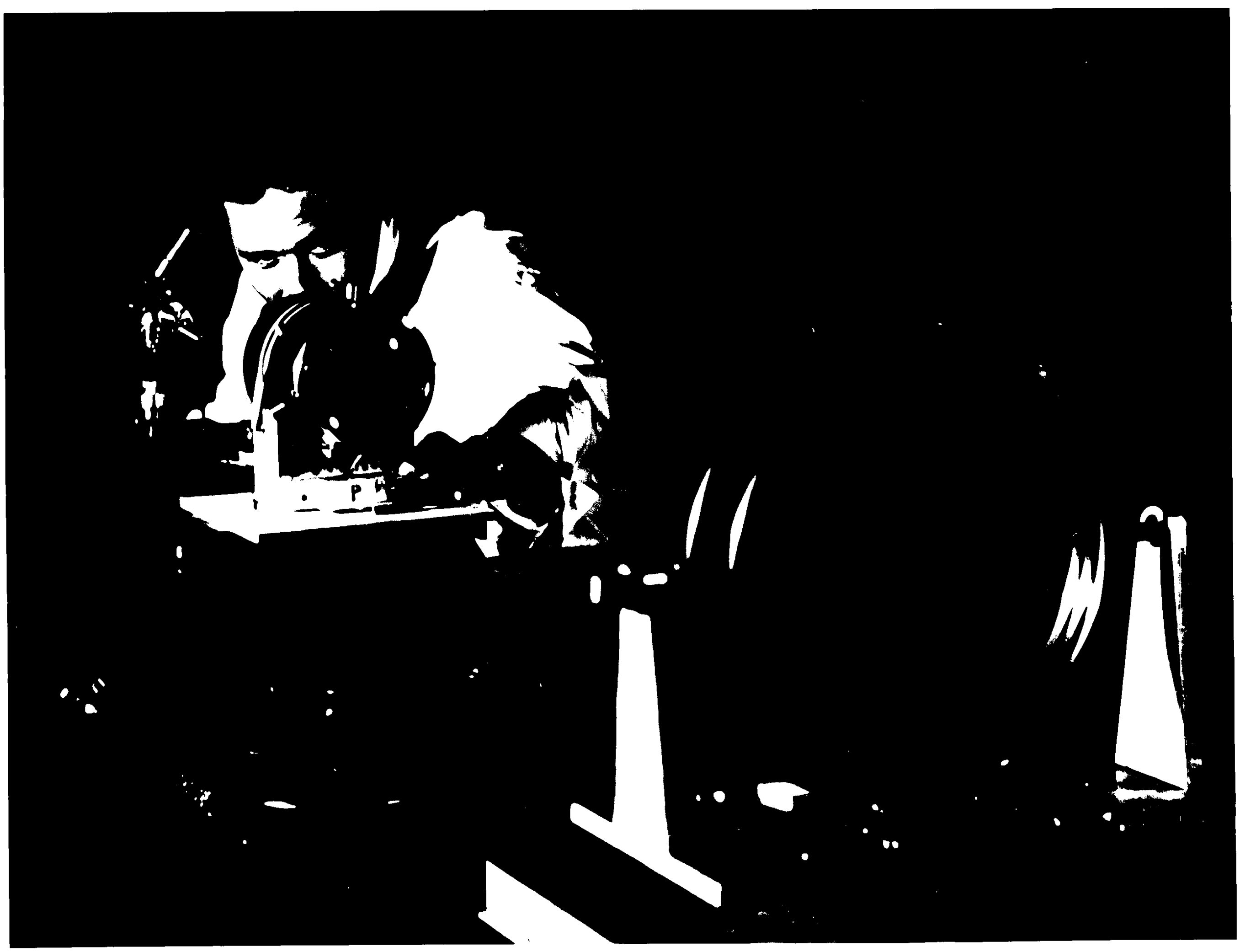

FIG. 15 RESOLUTION TEST ON FIRST HYAC II LENS

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2.4.2 CELLS

Figure 16 shows the final lens cell design (fabricated from aluminum) including filter housing. The lens elements and filter are of glass blanks for test purposes.

Figure 17 shows an early design in a holding jig which has been given shock and vibration tests. Preliminary vibration tests indicated some eleven resonances in the 200-2600 cps range. The final design of the cell, although the tests are not complete, promises satisfactory results as far as physical damage to the optics is concerned. At this time, no tests have been conducted using flight optics in the beryllium cell so that we cannot say that there will be no optical misalignment. Tests to insure that this is not degrading are planned soon.

Delivery of the first pure beryllium lens cell of the final design was made by the vendor machine shop. (See Figure 18.) Delivery of subsequent units is expected according to schedule. This first cell is now in the optical shop for assembly and centering operations with the lens elements. Beryllium seems to be completely satisfactory and since delivery will not present a problem, it will be used in the flight articles.

Figure 19 shows a trifilar pendulum used for inertia determination and momentum balance experiments.

2.5 FILM

2.5.1 ILLUMINATION

From the illumination data and the graphs of usable photographic time throughout the year and day previously presented, a series of graphs are now under preparation which will indicate the proper development time or relative development time for a fixed camera exposure as a function of time of year and day.

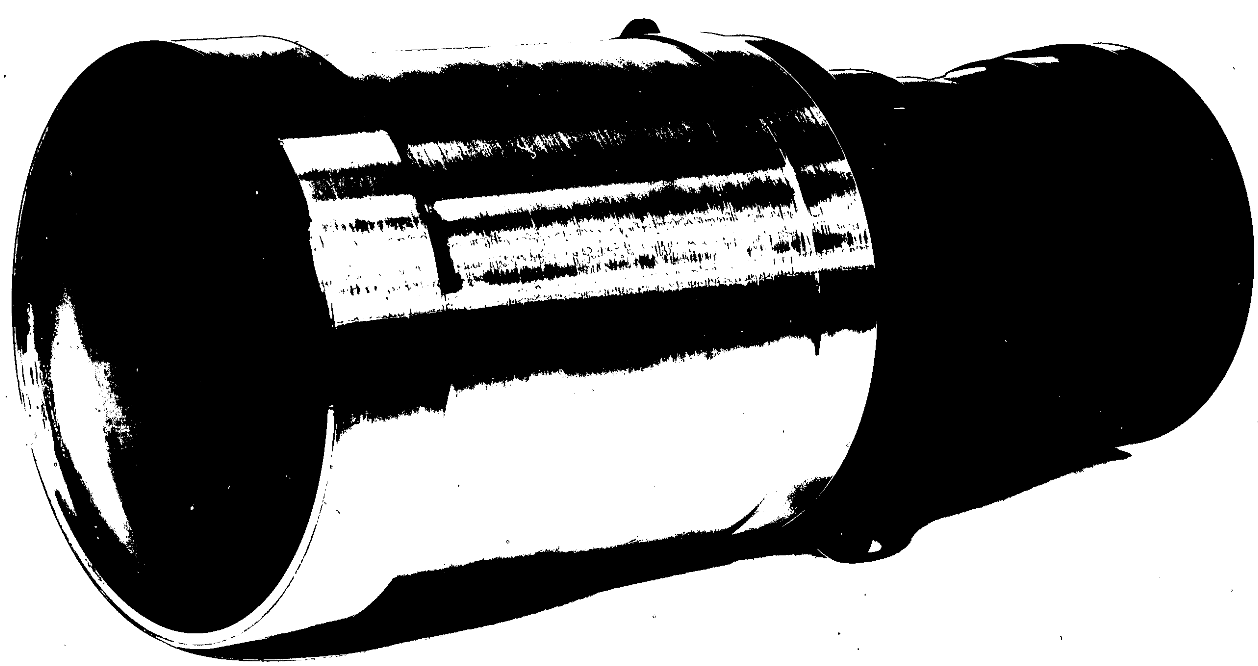


FIG. 16 FINAL LENS CELL DESIGN

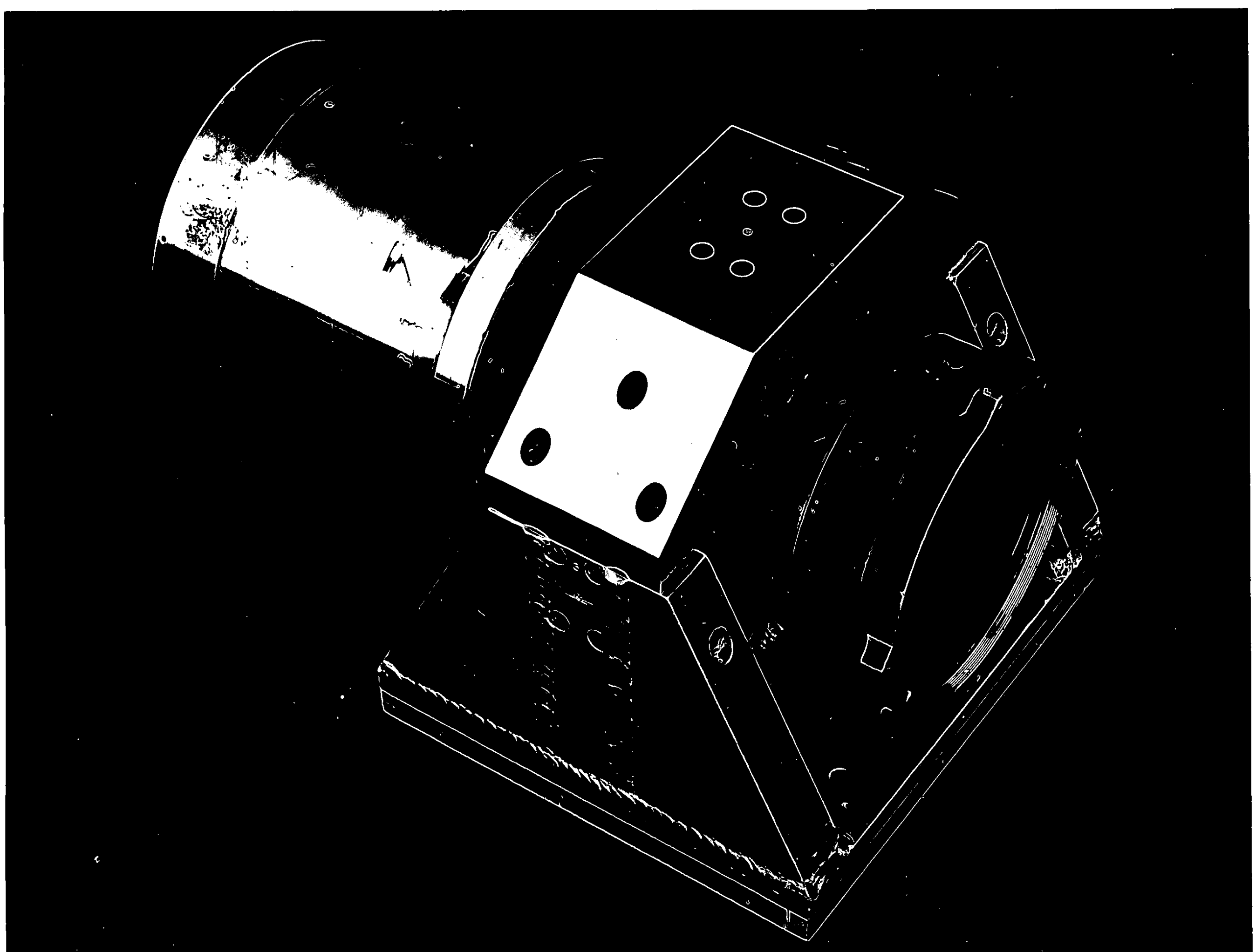


FIG. 17 ENVIRONMENTAL TEST LENS CELL JIG

FIG. 18 FIRST BERYLLIUM LENS CELL

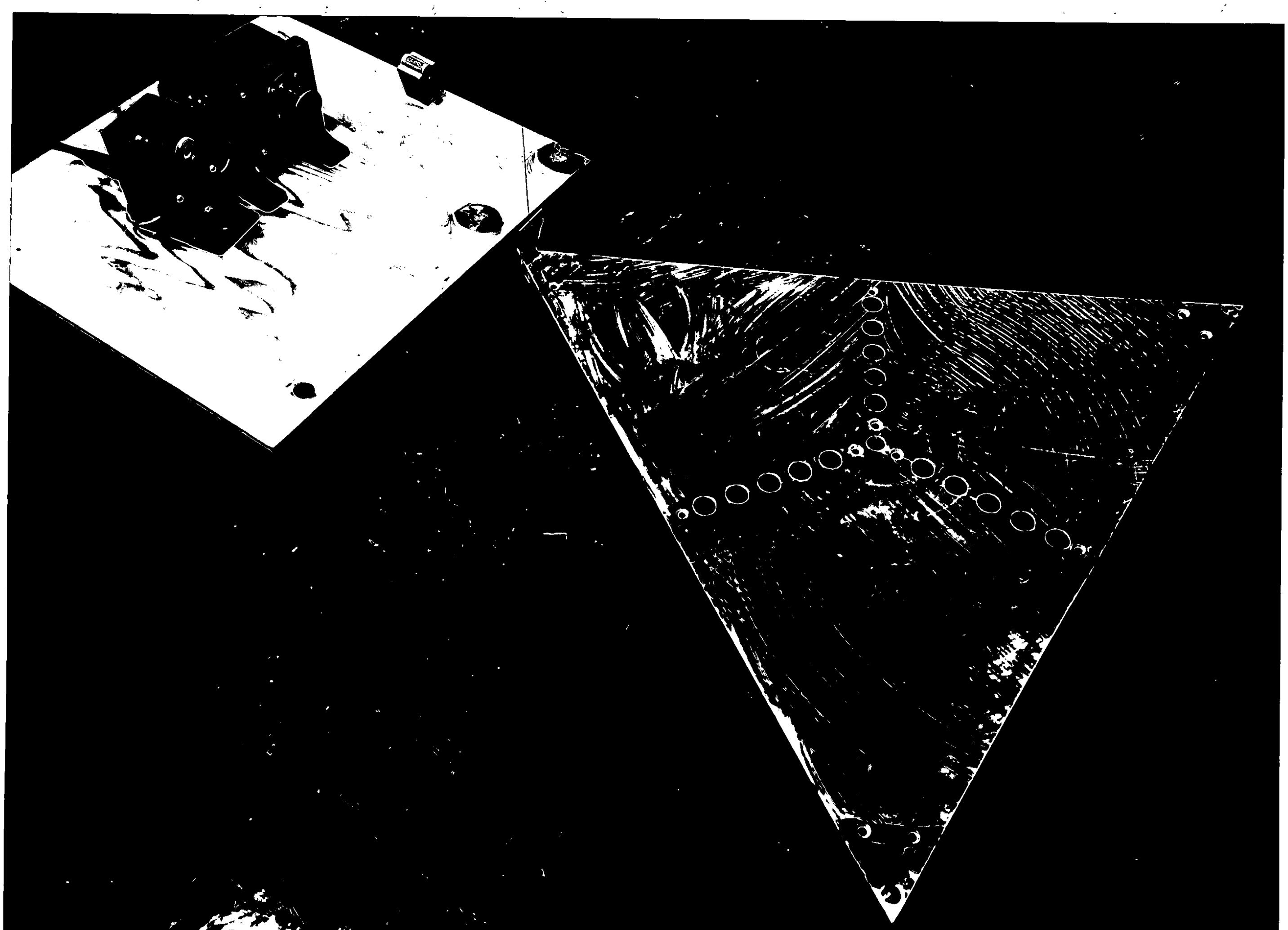


FIG. 19 TRIFILAR PENDULUM

The presently planned method of presentation is to present a series of curves of development time as a function of time of day, with the time of year as a parameter. These data will be published in the next monthly report.

2.5.2 FILM STATIC STUDY

The transport mock-up shown in Figure 20 will be placed in the environmental chamber for final testing. Tests are temporarily at a stand-still awaiting delivery of the static charge VTVM.

2.5.3 IMMERSION TESTS

A laboratory sea water solution was prepared for immersion tests on SO-1188 film.

Test 1 - One 100 foot spool of SO-1188 was immersed for two hours. The film had been previously wound at about 3 lbs. tension. Result: Approximately the first four feet were damp, and considerable sticking occurred. No emulsion was removed. Edges throughout were swollen and wet, for a distance of about 1/4 inch in from the edge. After the same roll was set aside to dry for two days, upon unwinding some emulsion was actually pulled off where the pelloid gel backing had cemented itself to the emulsion against which it was wrapped.

Test 2 - Several strips of SO-1188 film were allowed to soak in an open tray of sea water. In about 30 minutes both the emulsion and the pelloid backing became very slippery and soft, and were easily damaged in handling.

Test 3 - A similar test was conducted in fresh water. In this case, the emulsion and backing both completely dissolved off the base in about two days. During the first thirty minutes, the

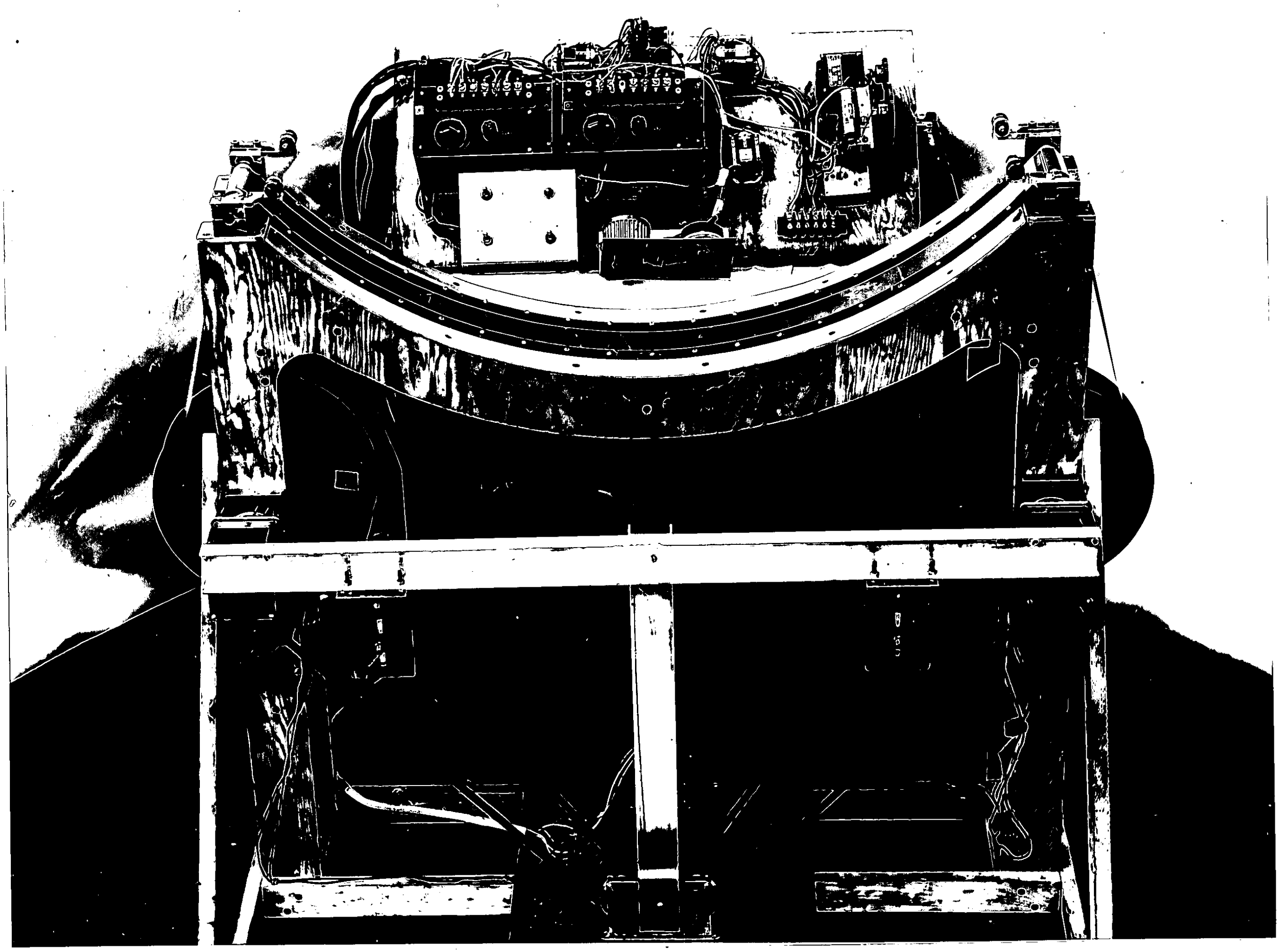


FIG. 20 FILM TRANSPORT MOCK-UP FOR STATIC DISCHARGE TESTING

behavior and physical condition were similar to that in the sea water test.

Test 4 - Two 100-foot rolls of SO-1188 film were wound under two pounds tension; one on a spool with flanges, the other on a spool without flanges. These were immersed in sea water at 80° F for thirty minutes, removed, and examined.

The roll with the flanges showed penetration across the width of the film for the first 18 inches of the film; it stuck but pulled free without emulsion damage. The film showed a penetration throughout the full roll for a distance of about 1/32 inch from the edge.

The roll without flanges was wet fully across the width of the film in a random fashion for the first 30 inches of film. The edge penetration varied from 1/32 to 1/8 inch throughout the roll.

Test 5 - These same rolls were wrapped again, and soaked for an additional six hours. After this period, the first two feet or so was badly stuck, but no emulsion pulled off the base. Swelling had occurred irregularly, so that there appeared to be trapped pockets of air. Penetration from the edge was about 1/4 inch.

Test 6 - Both rolls were retaped and soaked for an additional two days. Considerable effort was required to pull the stuck film loose from both rolls. Rather complete penetration had occurred for about the first four feet of film. Edge penetration throughout the remainder was still less than 1/4 inch.

Test 7 - These rolls were then allowed to dry for two days. After this time, considerable cementing of pelloid backing to gelatin occurred, and it was not possible to separate the film without pulling emulsion off the base.

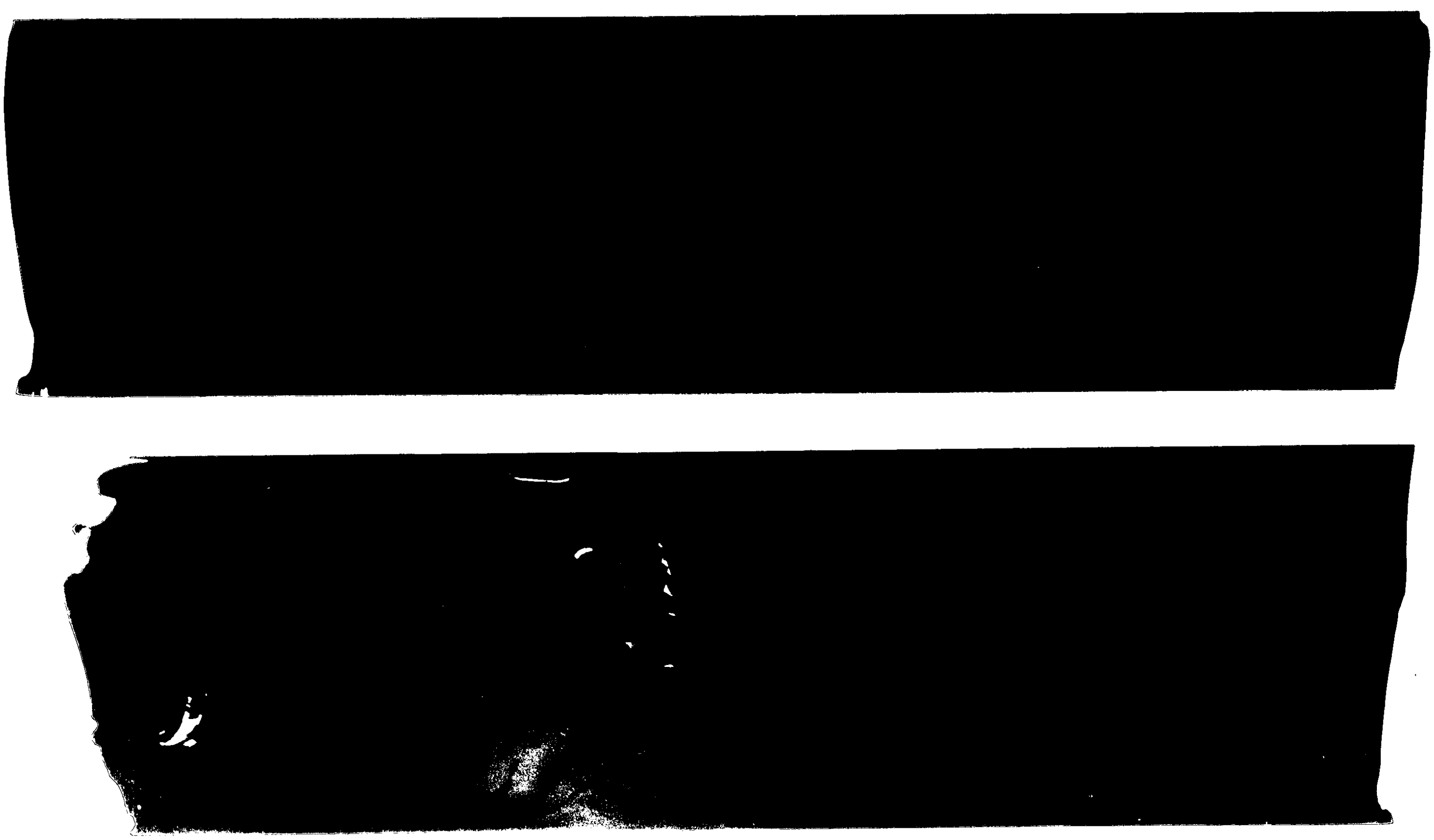


FIG. 21 IMMERSION SAMPLES

In Figure 21, two strips of SO-1188 film are shown after six hours immersion. The strip on the left was unrolled immediately after immersion, the one on the right was allowed to dry for 48 hours before peeling. Note the dark area where emulsion was pulled off the base.

Conclusions - It is obvious from these tests that salt water immersion for several hours will cause edge penetration to a depth of up to 1/4 inch, and several feet on the end of the roll may be wet in an irregular pattern across the width of the film. It is possible to separate the wet portions, provided little drying is allowed to occur. If drying is allowed, the danger of pulling emulsion off the base is greatly increased. In the areas where complete wetting occurs, the photographic image will be severely affected; the degree of damage to the latent image will depend on the duration of the immersion.

2.5.4 EFFECTS OF HIGH ALTITUDE ENVIRONMENT ON SO-1188 FILM

Sensitometric

A number of experiments have been conducted using the high vacuum chamber on the effects of very low atmospheric pressure and low humidity on the speed and contrast of SO-1188 film. To date, no significant changes in either property have been noted, at pressures as low as 80 microns of Hg.

When the small environmental test chamber is received, the effect of low humidity will be more completely investigated, both on the photographic response and the physical properties of the material. However, it appears now that little problem will exist with respect to the photographic response of the film.

Physical

One significant series of tests has just been completed in the same vacuum chamber at about 80 microns pressure. In these tests, five strips of SO-1188 film were hung under tensions of 1, 2, 3, 4, and 5 pounds, for a period of

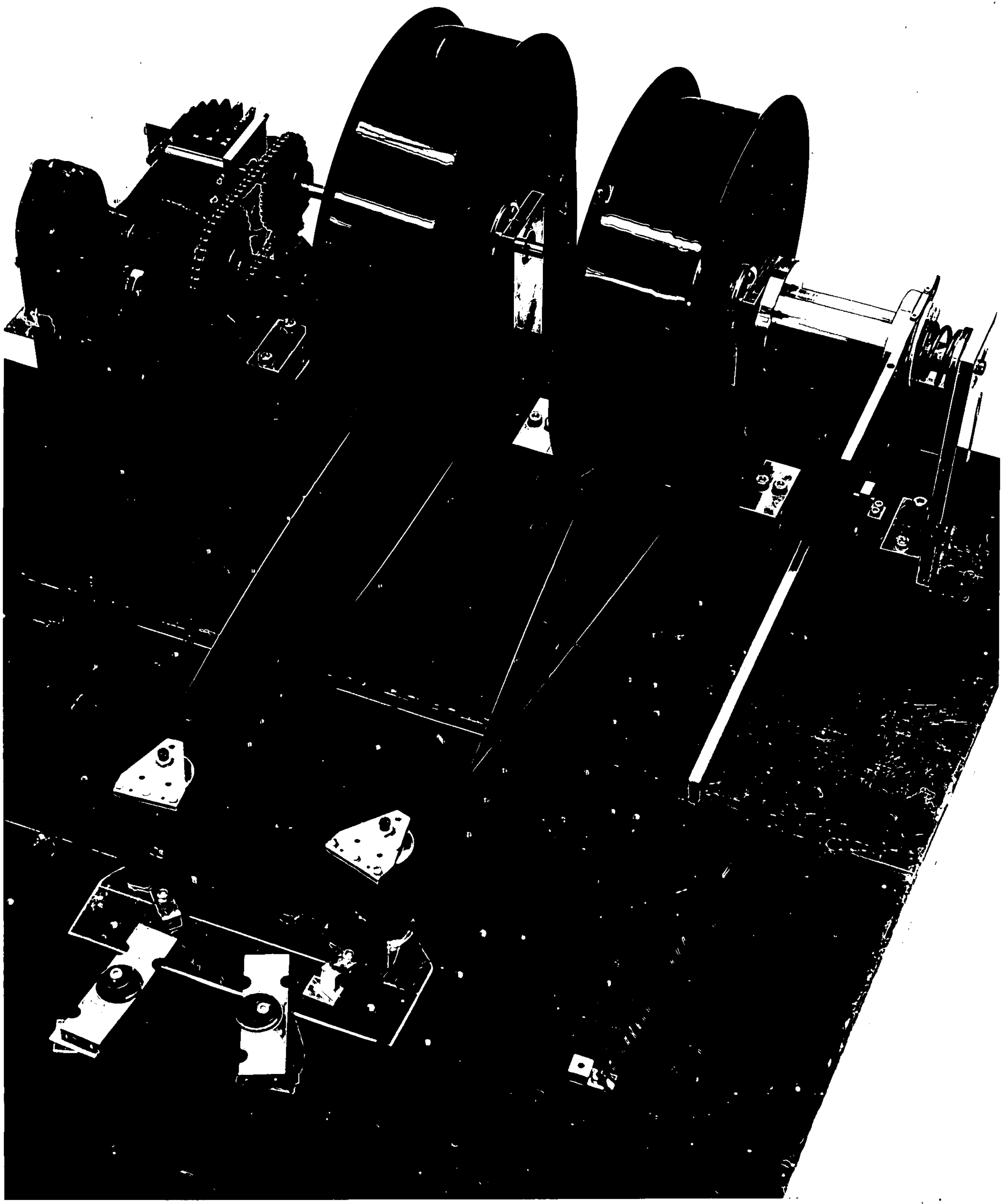


FIG. 22 FILM TRANSPORT MOCK-UP - AIR TWIST APPROACH

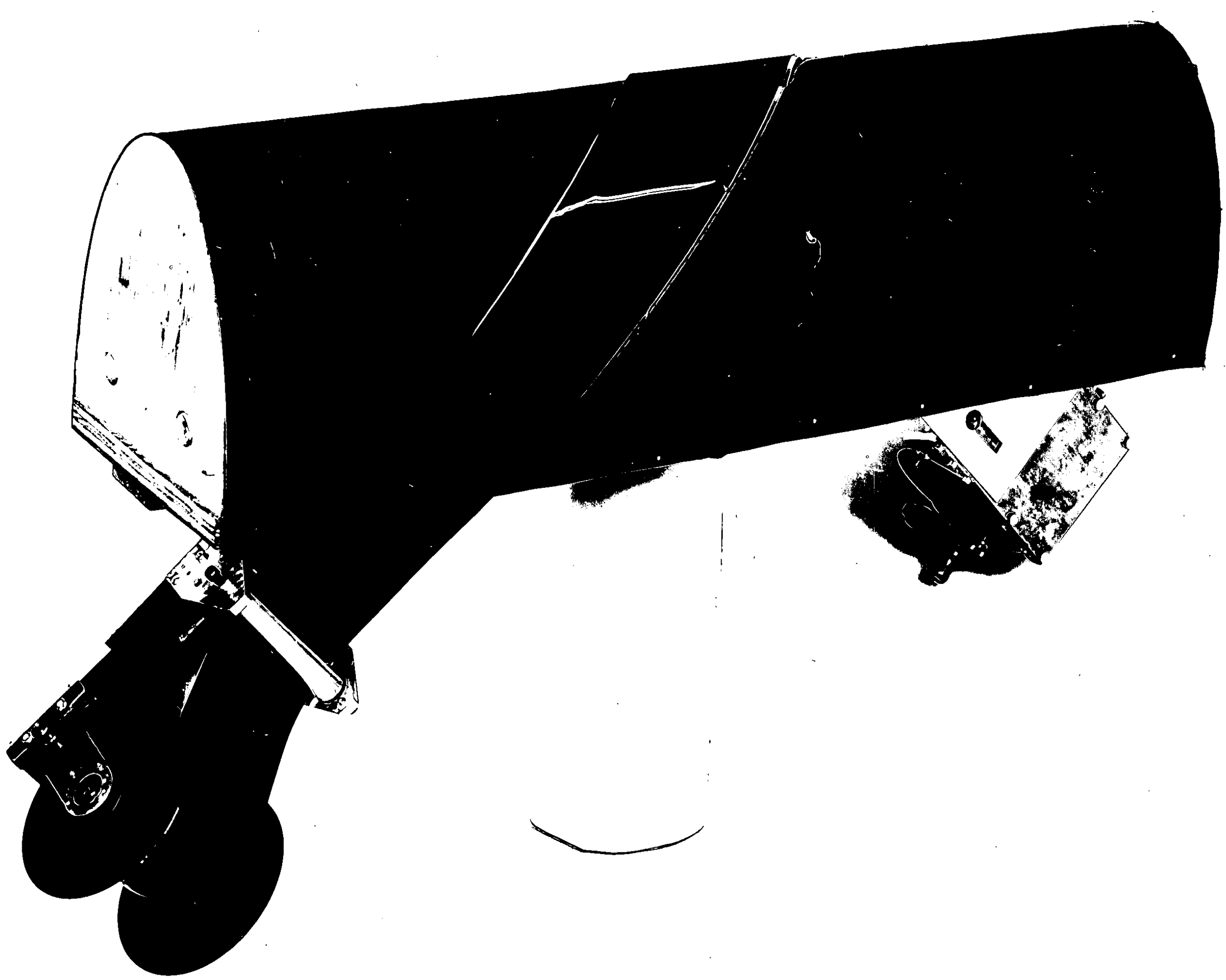


FIG. 23 FILM TRANSPORT MOCK-UP - HELIX APPROACH

twelve hours. The strips were suspended over a roller of aluminum, one inch in diameter. The purpose of this test was to determine if a permanent set in the film occurred in this range of tensions and time. After removal, each strip was examined three times, with approximately a ten-minute lapse between checks.

Immediately after removal, all five strips exhibited a very definite set around the roller. The 3, 4, and 5-pound tensions, in addition, produced slight pock marks in the gelatin where it was wrapped around the roller. The curl, or set, was progressively worse with increasing tension.

On a second inspection ten minutes later, all strips lay flat; the 2, 3, 4 and 5-pound tension strips still showed roller markings. After an additional fifteen minutes, all strips were flat, and the markings had vanished.

Immediately after removal from the chamber, all strips exhibited noticeably smoother surfaces than untreated film, and were definitely more brittle. In the absence of the folding endurance tester, which is on order, it was not possible to obtain any quantitative data regarding brittleness.

Shown in Figure 22 is a mock-up which will perform reliably the required film path bending in vacuum. This is an alternate approach accomplishing the bend by an "air" twist. Some trouble has been encountered occasionally with this mock-up because of stickiness due to moisture being formed.

Figure 23 is a mock-up of another alternate film bending transport involving rollers which have axes perpendicular to the required helix. This mock-up has a lot of merit and will be further tested.

We are presently awaiting the delivery of an environmental test chamber, a tensile strength tester, and a folding endurance tester. Delivery on all items is expected within the next month.

2.6 SIMULATOR

The static simulator scheduled for delivery in October to Fairchild is designed to accomodate the Fairchild-fabricated camera and cassette in a rigid fixture and supply moving resolution targets proportional to the V/H of the vehicle at nadir, approximately 15 degrees on one side, and thirty degrees on the other. It will have the capability of varying the direction of the ground motion to simulate a yaw error effect. The purpose of the unit at Fairchild is to perform such testing as may be required during camera development by Fairchild, and for acceptance testing of the completed units on delivery.

An additional static simulator of nearly identical capability will be furnished to the prime for similar testing at the prime's plant during assembly of the complete package. This unit at the prime's plant, to be delivered in December, will have the same fixture for tying the camera and cassette together for testing as the unit at FCIC. In addition, it should have the capability of accepting the complete conical package and supporting the load of approximately four to five hundred pounds. Since the design freeze, however, the length of this package has increased by six inches. A modification of the simulator is being attempted. An additional simplified static simulator will be supplied to the prime for base use. The exact requirements have not been frozen at this point but as a minimum, this might consist of one of the collimator units including the V/H drive servo. This could be either fastened to the prime's handling dolly or in some other way held relative to the camera for test. At the other extreme, it could be a complete static simulator identical to the other units.

The design of the static unit is 95 per cent completed. Approximately 95 per cent of the parts have been ordered, and the first base for the static simulator has been delivered to ITEK. (See Figure 24). The design of the collimator optics has been completed. The test plates have been fabricated in the

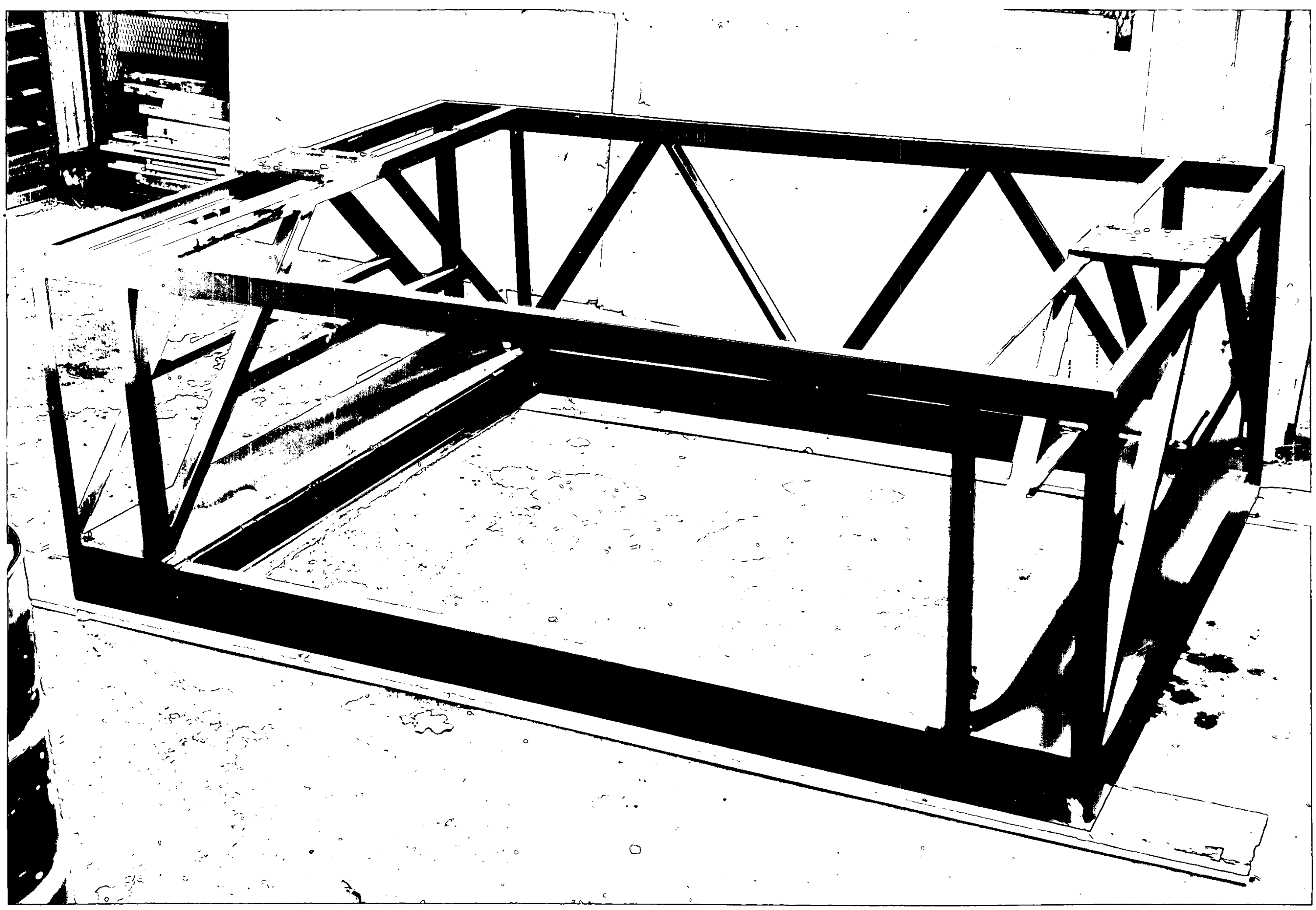


FIG. 24 SIMULATOR BASE

optical shop and glass for fabrication of the collimator lenses has arrived at Boston Airport from Germany. Unfortunately, it has been delayed by U.S. Customs for a few days, jeopardizing the delivery schedule to some extent. It is still hoped, however, that the 1 October date of completion and assembly of the unit will be met, for delivery to Fairchild soon thereafter.

A complete set of two foot long film strips containing resolving power targets spaced at 3/4 inch intervals was completed, but rejected after it was learned that the collimator focal length is such that only a reduction of 2x in the image size will take place. To achieve film targets having well-resolved and rectangular patterns at 100 lines/mm (this produces a maximum test resolution of 200 lines/mm in the camera), it is necessary to go to a finer-grained film than Micro-File. Accordingly, a new set is being made on an Eastman Experimental Film, which has a maximum resolving power capability of close to 500 lines/mm. It is expected that these will be completed by the required date. It may prove necessary to prepare a similar set of film strips having black background surrounding the targets, to minimize stray light. In this case, it will be necessary to develop a reversal process for this film.

The dynamic simulator unit to be retained at ITEK for use in type testing at the Waltham and environmental test facility is proceeding concurrently with the static units. The air bearings used for supporting the gimbals have progressed quite favorably. Current estimates on stiction torques of these bearings supporting the required 500 lb. load is in the neighborhood of 0.002 in/lbs . This unit will be gimballed on two axes to permit relative rotation for test and simulation. In addition, torque drive units will be placed on these two axes for introducing rates to the unit by command. Means of sensing these rates on two axes will be provided in the dynamic simulator unit as well as a special console including a Visicorder for recording appropriate parameters. This unit is scheduled to be operating in December at the ITEK test facility.

2.7 SELECTION OF PROCESSOR TO BE USED IN CONJUNCTION WITH CAMERA TESTS

A Fisher "Processall" was obtained on loan for tests. This is a very compact unit approximately four feet in length by thirty inches high by twelve inches wide, mounted on casters. The power requirements are about 1100 watts of 110 volt a.c. The developer and fixer capacity is 2 1/3 gallons. Film capacity is approximately 500 ft. of standard base (approximately 850 ft. 3 1/3 mil base). The developing speed is approximately three feet per minute which is limited by drying capacity. This gives approximately 40 seconds development time. Both hypo and developer have thermostatic temperature control from ambient up to 100° F. The developer and fixer are circulated through a simple heat exchanger if cooling is required. There appear to be several advantages to this unit.

1. Size - It is compact and portable.
2. Simplicity - The only possible trouble areas may be in pump and drive motor breakdown. These components could be provided as spares and readily interchanged.
3. Tracking - It appears to be good for both standard and thin-based emulsions which were confirmed by tests in our facility.
4. Development - Complete range for 1213 (1221) emulsion equivalent to test results given from two minutes at 72°F to 12 minutes at 90°F.
5. Scratches - Only minor problems exist, mostly associated with poor squeegee before drying chamber.
6. Threading and loading - Good.

Disadvantages:

1. Drying - This is not the most efficient due to poor air circulation which could be improved. The drying now limits the speed of operation but with the present dryer,full development range can be obtained.

2. Development - Uneven development at high (90°) temperature. The reason for this has not been determined at present. It may be due to poor circulation of developer and blocking of spray openings. An even development was obtained at 72° F after cleaning of spray system. This will require further tests.

3. Film Drive - There is a poor clutch on the take-up spool. This could be improved without a significant effort.

4. Floating Cassette - The design is poor since it is too close to the development tank, permitting possible leakage of solution into cassette. This can be modified and adapted to 70 millimeter use only.

3.0 WEIGHT SUMMARY

	ESTIMATE Jun 6	Jul 10	Jul 26	Aug 9	Aug 23	Sep 6	Sep 20
Camera - Wt. Summary (Lbs.)							
Lens Assy.	5.00	6.70	5.38	5.38	5.38 a	5.38 a	
Lens Shaft	1.50	2.47	2.47	1.28	1.28 e	1.28 e	
Lens Drive Mech	4.00	5.40	5.40	5.40	5.40 c	5.40 c	
Boots & Light Seal	1.00	.66	.66	.66	.66 e	.66 e	
Stove Pipe Assy	1.00	1.65	1.65	1.65	2.07 c	2.07 c	
Platen	1.50	.71	.71	.71	.71 c	.71 c	
Data Recording Components	6.00	2.76	2.76	2.88**	3.31**a	3.35**a	Includes 2.00 lbs.
				allotted by Prime for Digitote			
Structures	8.00	18.28	20.28*	22.86*	19.35* c	19.35*c	Includes 2.00 lbs.
			alloted by Prime for mounting ring 7-10-58				
Supply Spool & Bearing Assy.	10.00	4.88	4.88	3.45	3.51 a	3.51 a	
Skew Rollers	1.00	.84	.84	.51	.51 c	.49 c	
Straight Rollers	1.50	3.26	3.26	3.26	2.51 c	2.53 c	
Film Handling Brakes & Clutches	2.00	2.15	2.74	2.72	1.96 a	1.96 a	
Shuttle	.50	.95	.95	.39	.39 c	.62 c	
Film Handling Drive	.70	2.70	2.70	2.35	2.55 c	2.54 c	
Drive Motor & Assoc. Gear	8.00	7.04	7.04	6.77	6.12 c	6.14 c	
Misc. Elec. Equip.	3.00	3.71	3.71	5.20	6.35 a	6.35 a	
WL Balance S.P. & Lens	4.00	3.93	3.64	3.64	3.64 c	3.64 c	
Iω Balance Supply Spool	3.50	2.51	2.51	2.51	2.79 c	Deleted	
Iω Balance S.P. & Lens	3.00	3.30	3.30	3.30	3.30 c	3.30 c	
Misc.							
Camera Total	65.20	73.90	74.88	74.92	71.79	69.28	
Cassette							
Housing and Structures		7.4	7.4	5.75	5.75 c	6.00 a	
Seal		1.5	1.5	Deleted	--	--	
Rollers		.3	.3	.30	.20 c	.23 a	
Belting		.5	.5	.50	Deleted	--	
Film Drive Arm		1.5	1.5	1.50	.62 c	.70 c	
Spool		4.86	4.86	3.45	3.51 a	3.33 a	
Motor & Drive		1.6	1.6	1.60	2.85 e	1.61 a	
Solenoid & Drive		1.2	1.2	1.20	.28 e	.26 c	
Misc. Elec. Equip.		1.25	1.25	1.25	1.34 e	1.25 e	
Cassette Total	20.00	20.11	20.11	15.55	14.55	13.88	
Film		40.00	40.00	40.00	40.00 c	40.00 c	
TOTAL (LBS.)		134.01	134.99	130.47	126.34	122.66	

C.G. of Camera (unloaded)			Jul 10	Jul 26	Aug 9	Aug 23	Sep 6	Sep 20
	x	Pitch	2.66				1.91	
	y	Yaw	13.60				12.33	
	z	Roll	4.37				3.87	

a - Actual Weight
c - Calculated Weight
e - Estimated Weight

4.0 POWER ESTIMATE

There have been no significant changes in the over-all power estimate. However, the individual electronic and electro-mechanical units are being reviewed individually as the various operating breadboards are physically realized to prove the actual versus the estimate, and for operating duty cycles.

HYAC II: SIGNIFICANT MILESTONES

CAMERA

1. 90% OF TOTAL RELEASED
2. SPOOL DELIVERY BEGUN ON SCHEDULE (35 TO DATE)
3. CAMERA SIDEPLATES WITHSTOOD VIBRATION TEST SUCCESSFULLY
4. LENS DRIVE BREADBOARDED AND OPERATING
5. SCAN SERVO SYSTEM HAS BEEN SUCCESSFULLY TESTED & RELEASED
6. HORIZON RECORDING SYSTEM COMPONENTS HAVE BEEN SUCCESSFULLY TESTED & RELEASED
7. DIGITOTE RECORDING TESTS COMPLETED AND SUCCESSFUL
8. NEW DESIGN CASSETTE HAS PASSED LIMITED ENVIRONMENTAL TESTING & BEEN RELEASED

LENS

1. FIRST UNIT ASSEMBLED
2. PRELIMINARY ASPHERIZING COMPLETED
3. FIRST RESOLUTION TESTS PERFORMED INDICATING 260 LINES PER MM. VISUALLY AND 100 LINES LENS/FILM ON AXIS
4. FIRST BERYLLIUM CELL RECEIVED
5. ENVIRONMENTAL TESTS ON ALUMINUM MODEL SATISFACTORY

FILM

1. TEST UNDER OPERATIONAL CONDITIONS SHOWED SET BUT NO FILM BREAK

PROBLEM AREAS

CAMERA

FILM DRIVE USING SMOOTH ROLLERS UNRELIABLE.

CURVED PLATTEN DESIGN UTILIZING ALUMINUM-LOCK FOAM DOES NOT MAINTAIN STABILITY WHEN MACHINED.

TITANIUM PLATEN CHOSEN DIFFICULT TO MACHINE AND BLACKEN.

FILM

A FILM SET TAKES PLACE AT ALTITUDE AFTER SEVERAL HOURS OF NON-OPERATION.

FURTHER IMMERSION TESTS CONDUCTED CONFIRM SERIOUSNESS OF FILM WETTING.

7.0 FUNDING STATUS

ITEK Corporation only

Period covered: 8/1 - 8/31 (Boston Facility)

5/1 - 8/31 (Waltham Facility

Purchases during this period not included

DIRECT LABOR

Engineering (Boston Facility)	$ 19,652.66		
Technicians (Boston Facility)	6,478.37	$26,131.03	
Fabrication (Boston Facility)		4,440.43	$ 30,571.46
Engineering (Waltham Facility)		$14,228.95	
Fabrication (Waltham Facility)		2,418.01	16,646.96
		TOTAL DIRECT LABOR	$47,218.42

OTHER DIRECT COSTS

Maintenance	10.73

OVERHEAD

Engineering & Technician - Boston:		
8/1 - 8/31/58 80% x $26,131.03 =	$20,904.82	
Fabrication - Boston		
8/1 - 8/31/58 90% x 4,440.43 =	3,996.39	
Engineering - Waltham		
5/1 - 8/31/58 80% x 14,228.95 =	11,383.16	
Fabrication - Waltham		
6/1 - 8/31/58 150% x 2,418.01 =	3,627.02	39,911.39
	SUB TOTAL	$87,140.54
General Administration 9% of $87,140.54		7,842.65
	GRAND TOTAL	$94,983.19

8.0 SPECIAL SUPPLEMENT

8.1 INSTRUMENTATION

8.1.1 LIGHT LEAK DETECTION

Photomultipliers as light leak detectors must be eliminated because of their weight and their requirement of high voltage. Using currently available solid state cells, such as the Clairex CL-404 cadmium selenide cell, the limit of detectable illuminance is felt to be about 0.001 foot-candles. Developmental cells of higher sensitivity may be available in limited quantities; this possibility is being investigated.

For SO 1188, the minimum detectable exposure is on the order of .0001 foot-candle seconds. Thus, the cadmium selenide cell can at best detect an illuminance level of sufficient intensity to produce a detectable density difference in ten seconds. It should be recognized, therefore, that illuminance levels sufficient to fog SO 1188 during the out-of-spool intervals anticipated are below the detectable limit of non-multiplier cells. Light leak detectors, if used, must be regarded as indicating gross leaks such as might result from skin fracture.

8.1.2 FILM RADIUS POTENTIOMETER

The radius of film on the take-up spool is to be monitored by a potentiometer whose voltage output varies from 0.5 to 4.5 volts as the spool radius varies from 2 to 10 inches. The sensitivity of this measurement is thus 500 millivolts per inch. If the telemetry link has sufficient resolution to permit the detection of temperature differences of 1° F, then radius variations of 40 thousandths will be detectable, assuming the potentiometer output is continuous. Under these circumstances, we may anticipate frame resolutions (i.e., number of exposures producing a detectable radius variation) of 2, 10 and 20 frames at the beginning, middle and end of operating life respectively.

The spool radius signal may also be used as a measure of ellipticity of film wrap if the telemetry resolution is high enough. Such an ellipticity, if sufficiently pronounced, might dictate a premature recovery because of shift in center of gravity.

8.1.3 TEMPERATURE MEASUREMENT

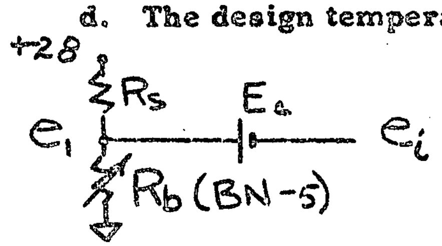
Design parameters: The design parameters affecting temperature measurement are as follows:

a. The input swing of the telemeter is from 0.5 to 4.5 volts.

b. Available direct voltage is 28 volts regulated.

c. Ruge Associates resistance thermometers have been specified. The maximum allowable steady-state current through these elements when mounted to a metallic heat sink is fifteen milliamperes.

d. The design temperature is 70° F.



Selecting R_s for 15 ma. in R_b at 70° F:

$$R_s = 28/.015 - 1200 = 665 \text{ ohms}$$

Selecting E_c to center the telemeter input swing at 70° F:

$$E_c = e_1 - e_i = (1200)(.015) - 1/2(4.5 - 0.5) = 15.5 \text{ volts}$$

Figure 25 is a plot of telemeter input signal voltage as a function of temperature. In the region of 70° F, the sensitivity of this divider is 19 millivolts per degree F. The telemeter system, including all elements down to the final readout, must have a precision of 1/2% in order to measure temperature to one degree.

If temperature resolution on the order of one degree is required, and if the noise figure of the telemeter link is too high to permit this resolution, a preamplifier can be introduced to narrow the temperature spread and increase resolution. Shown in Figure 26 are two possible preamplifier circuits with gains of ten, drawing less than five milliamperes from the regulated 28 volt supply.

8.2 GO-NO-GO CONSOLE

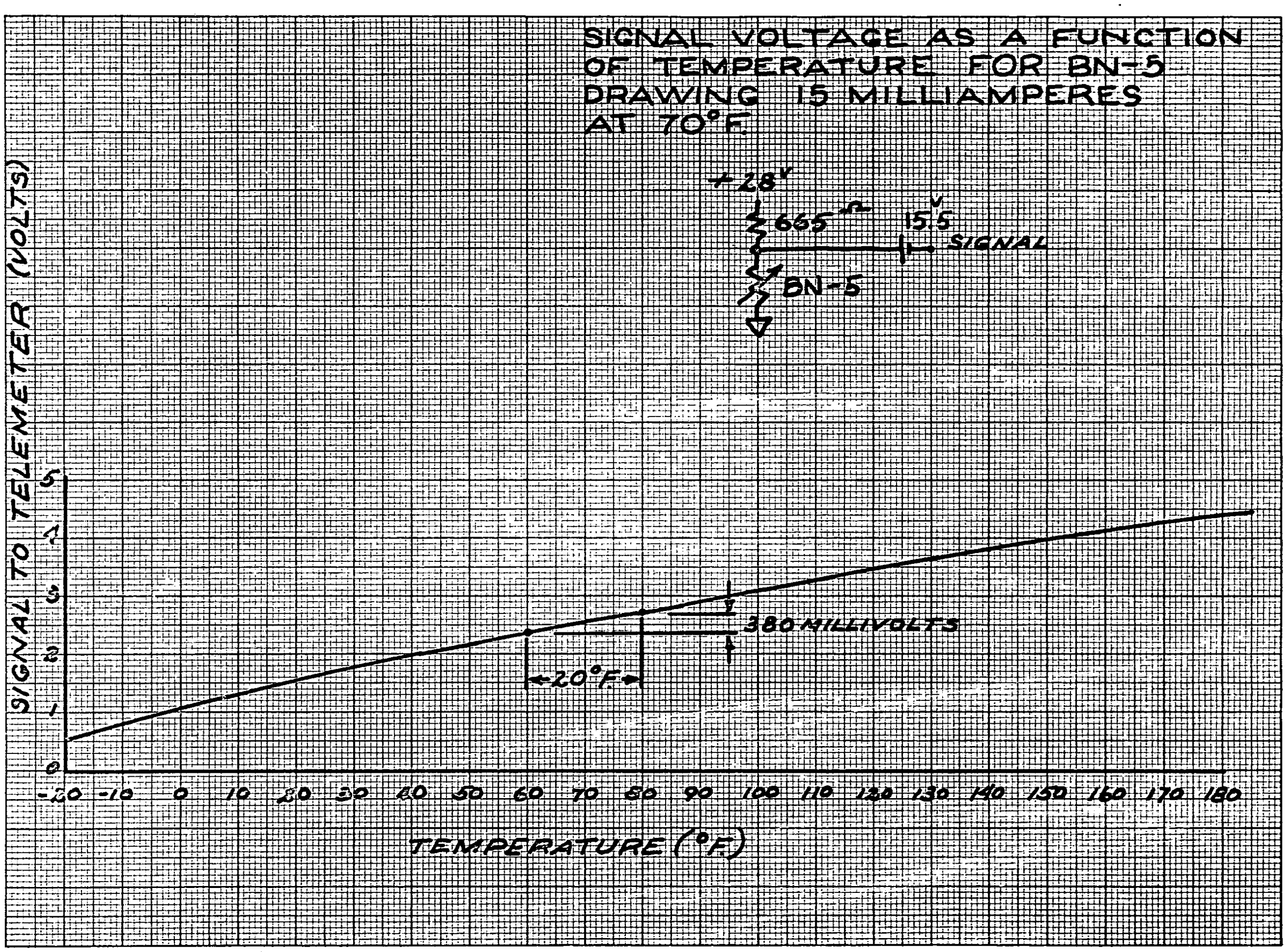
In order to determine just prior to launching that the camera is in operating condition, it has been proposed that a rack-mounted console be provided. This console would replace the test and check-out console in the blockhouse for reasons of security and simplicity, and upon interrogation would provide to the operator a single indication that certain conditions have been met. Three such conditions are currently visualized:

a. film is intact

b. the camera is cycling

c. there is no gross light leak.

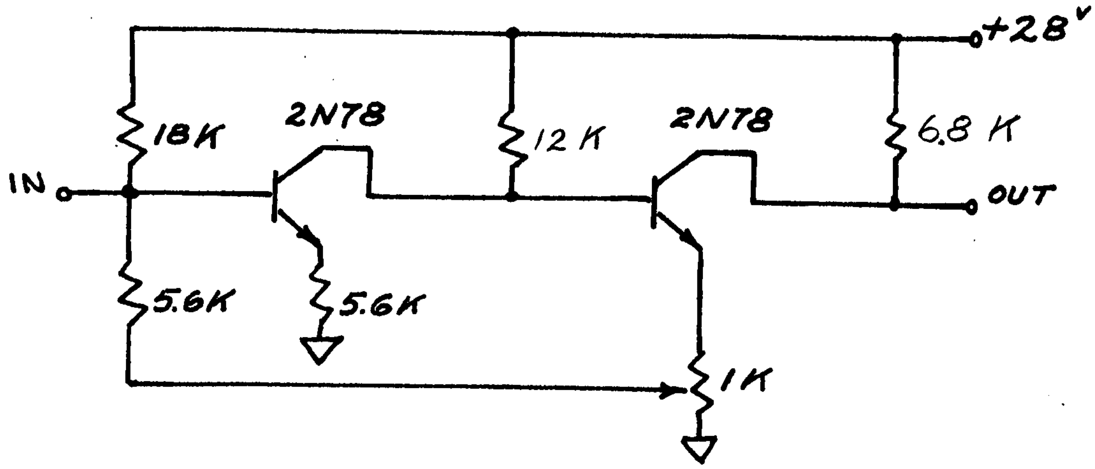
FIG. 25



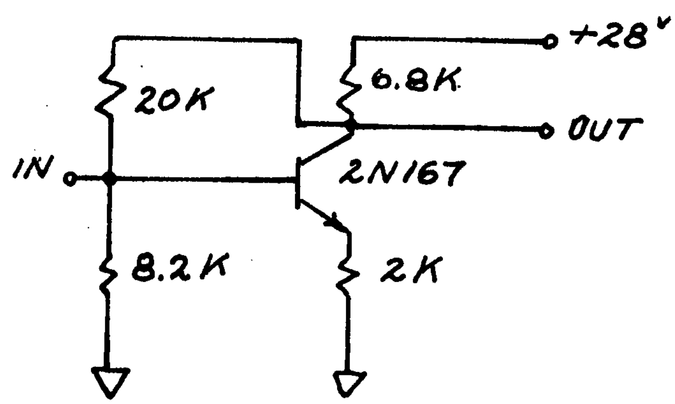
Approved For Release 2008/12/03 : CIA-RDP74B00752R000100300001-2

PREAMPLIFIER FOR TEMPERATURE MEASUREMENT

SPECIFICATIONS: 28^Vdc source
$2.3 - 2.7^V$ in
$0.5 - 4.5^V$ out

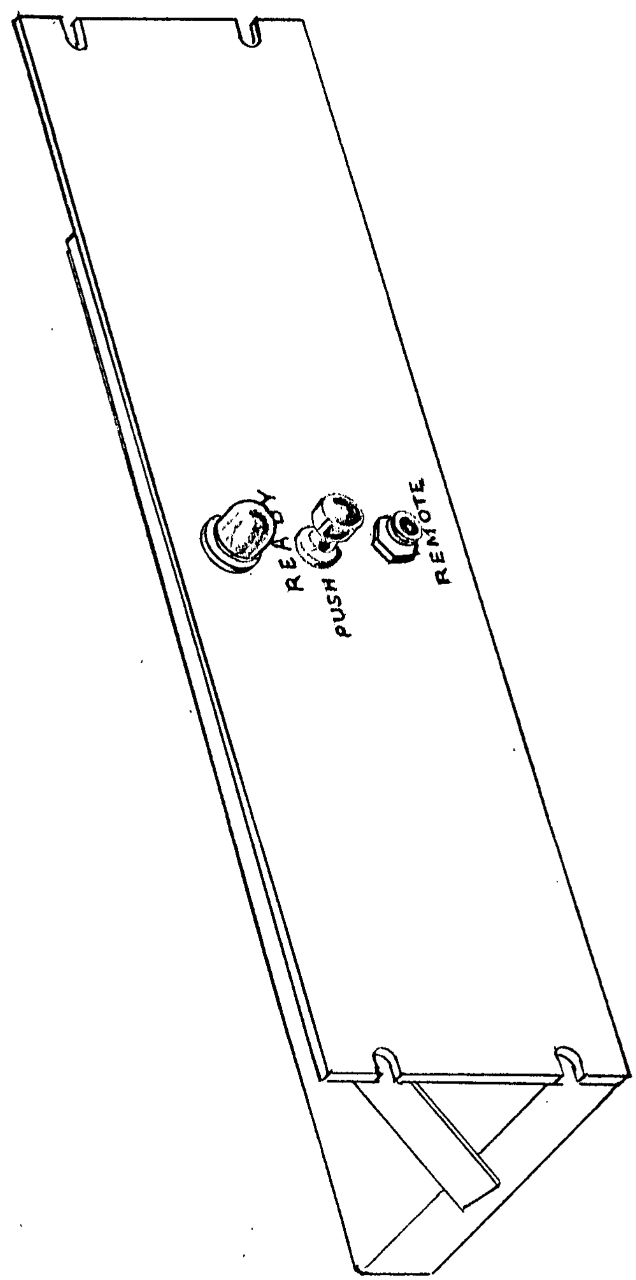


PREAMPLIFIER A



PREAMPLIFIER B

FIG. 26



GO-NO-GO CONSOLE

FIG. 27

8.3 TEST PROGRAM

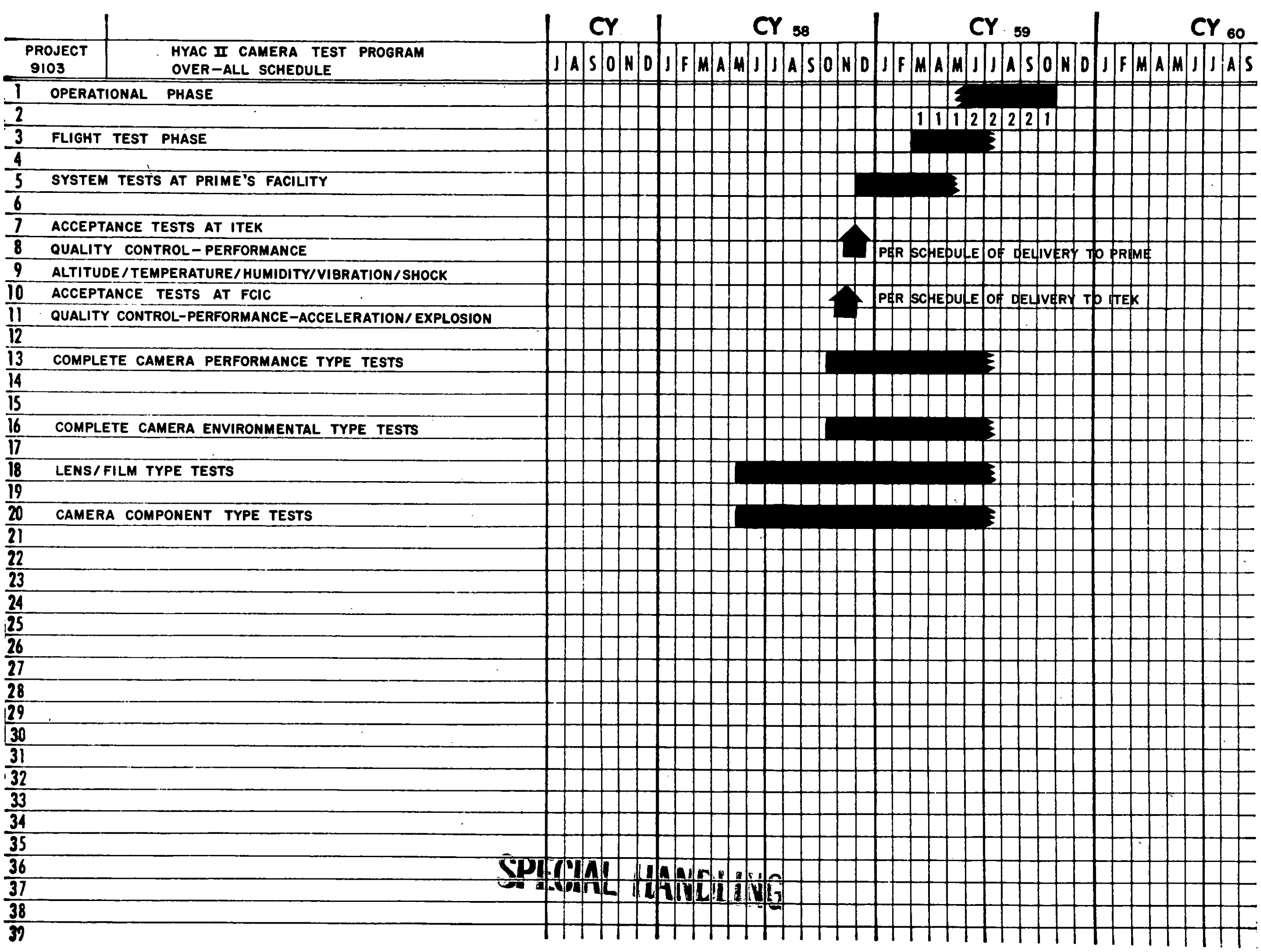
Figure 28 shows the Hyac II camera test program overall schedule. The schedule of the 12 camera flights is shown in line 2. Line 1 shows the latter flights as being made with operational units. Although, the first several flights may not be fully operational, at least this is the first test in flight. There will be system tests at the prime's facility beginning with delivery of the first camera/cassette and continuing. Lines 7 and 10 cover acceptance tests which will conform with delivery schedules of FCIC to ITEK and ITEK to prime. The camera type tests, both performance and environmental, include tests on the three non-flight units retained by ITEK/FCIC and are shown continuing into the operational phase. This is meant to show that my changes as the result of these test which can improve operational performance and reliability will be incorporated if the schedule can be maintined.

By the same token lens/film and camera component tests will be continued with the same objectives of incorporating test results.

Figure 29 GSE schedule indicates by location the proposed equipment and dates of delivery.

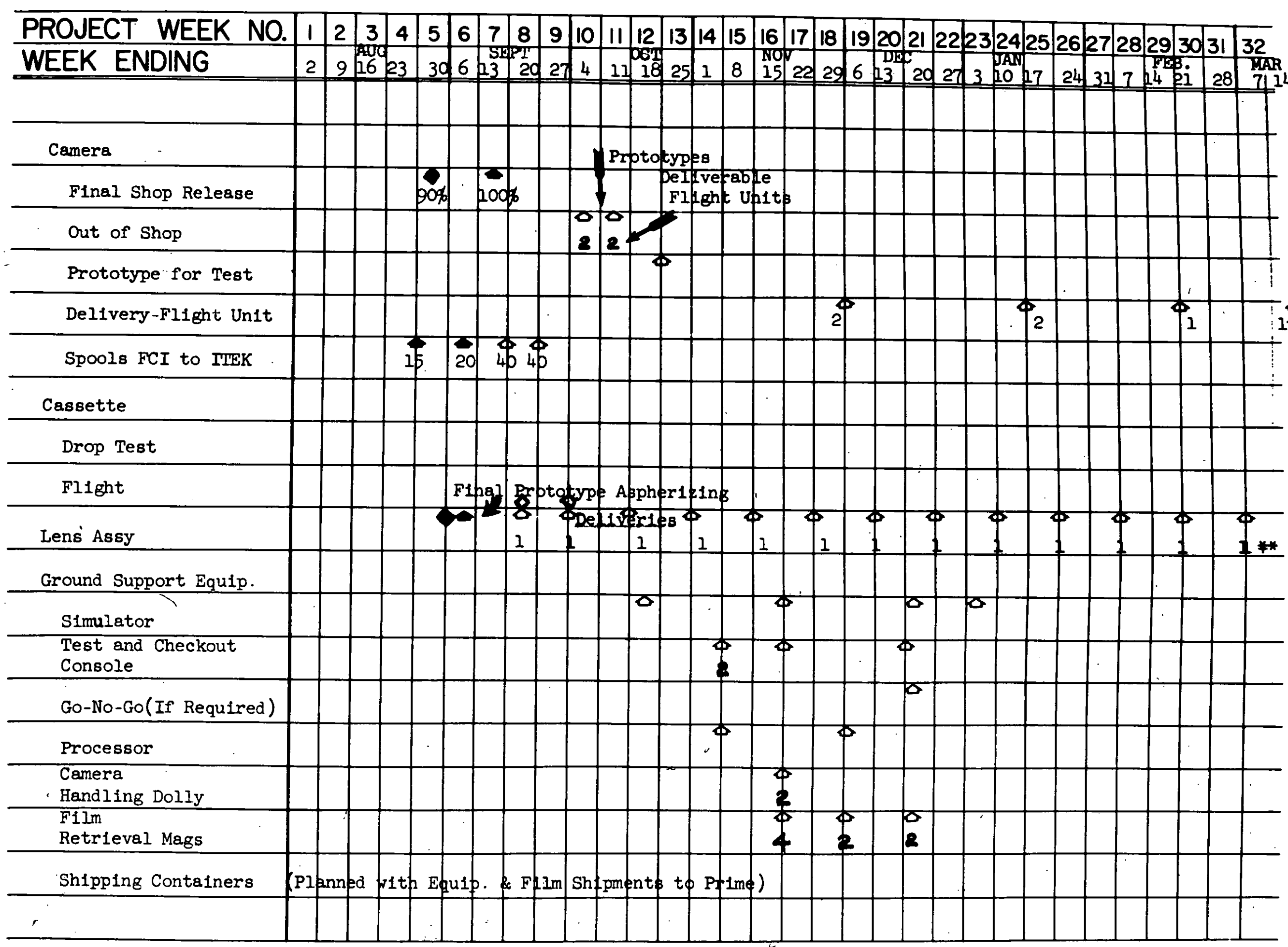
Figure 30 shows the current overall project delivery schedule which is more inclusive.

SPECIAL HANDLING



HYAC II
GROUND SUPPORT EQUIPMENT SCHEDULE

	ITEM	FCIC	ITEK	PRIME'S PLANT	BASE ASSY PLANT	BASE FINAL
	SIMULATOR	OCT. 15	NOV. 15	DEC. 15	* DEC. 30	—
	TEST AND CHECK-OUT CONSOLE	* NOV. 1	NOV. 1	NOV. 15	DEC. 13	—
	GO-NO-GO CONSOLE	—	—	—	—	DEC. 15
	PROCESSOR	—	NOV. 1	DEC. 1	—	—
	FILM MAGAZINES	(2) NOV. 15	(2) NOV. 15	(2) DEC. 1	(2) DEC. 15	—
	CAMERA HANDLING FIXTURE	—	NOV. 15	NOV. 15	—	—
	SPECIAL TOOLS	—	—	DEC. 1	DEC. 15	—
	* SIMPLIFIED VERSION SHIPPING CONTAINERS CAMERA - 1 EA. REUSABLE PER SCHEDULE CASSETTE - 1 EA. " " " PLUS 7 FOR TEST FILM - 120 ON INDIVIDUAL SPOOLS.					



* 2 per month to completion

** 1 per 2-weeks to completion

APPENDIX I

Description of Camera Operating Sequence
(Submitted in Response to Request from Prime)

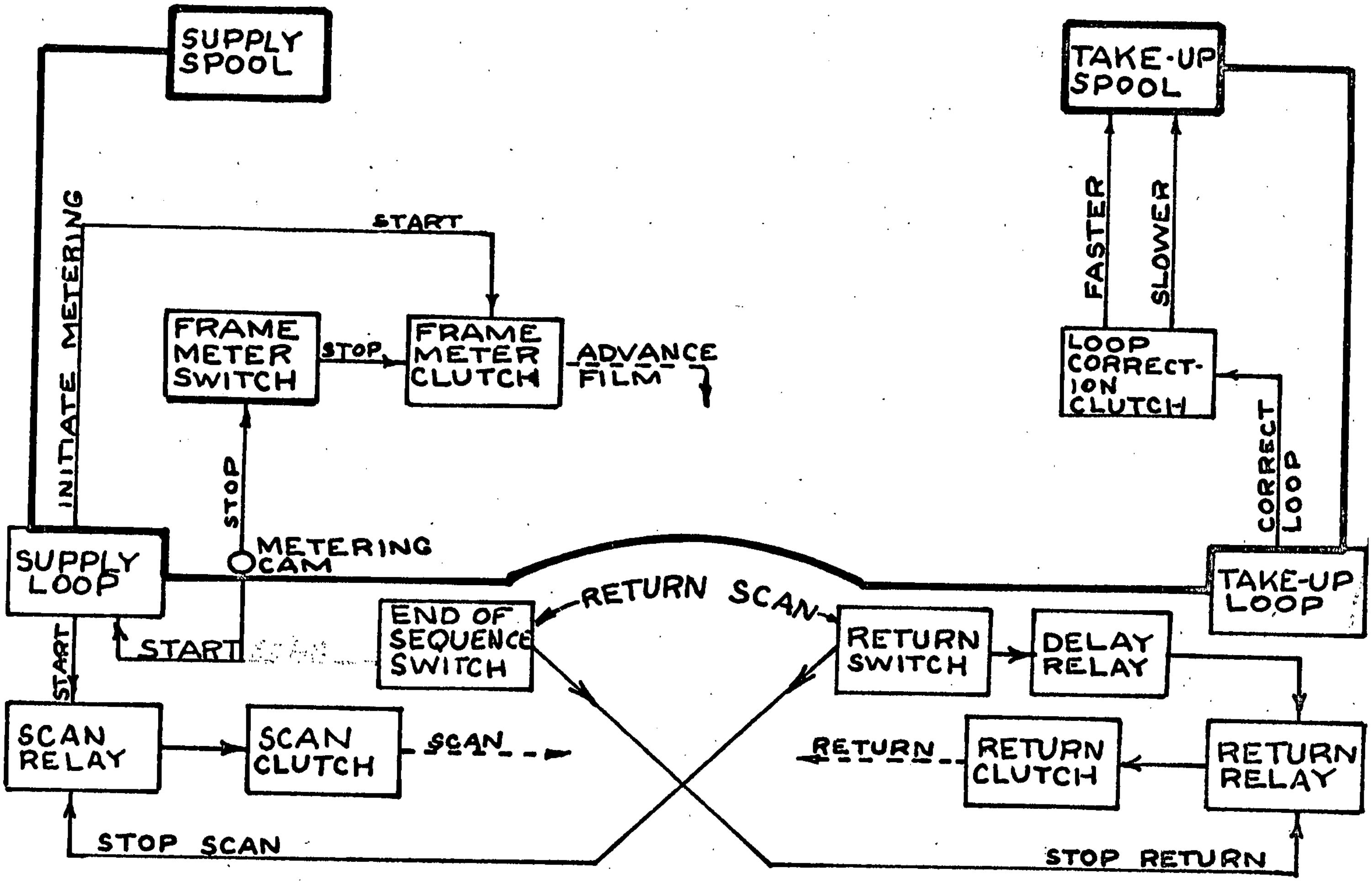
Operating Sequence:

Refer to Figure 31, Functional Block Diagram of Operating Sequence and Figure 32, Timing Diagram. During camera operation, supply loop metering rollers feed film into the supply loop at a constant rate of 19.52 inches per second (for design V/H of 0.0345 radians/sec.). When the supply loop is full, the frame metering initiating switch is actuated. This releases the brake on the frame metering rollers and engages the frame metering clutch. Engagement of the frame metering clutch drives metering rollers which advance film into platen. The amount of film advanced into the platen is metered by a metering cam and switch which act to disengage the metering clutch and engage the brake.

The complete revolution of the metering cam also connects the scan relay to the scan initiating switch which has meanwhile been actuated by the reduction of the supply loop. The scan relay energizes the scan clutch, causing the lens barrel assembly to scan through 70 degrees and actuate the return switch. This switch de-energizes the scan relay and clutch. After a delay (necessitated by the variable scan rate required) the return switch through the return relay energizes the return clutch, causing the lens barrel assembly to return to the left and actuate the end of sequence switch. This switch operates through the return relay to disengage the return clutch and engage the brake.

Since the supply loop is being fed continuously, the cycle is repetitive as long as the main drive motor is running.

Not shown on the functional block diagram is a nadir switch which is tripped by the lens barrel assembly as it passes nadir. This switch pulses a light source to record real time on the film between frames, using a Digitote time indicator. In series with the nadir switch is a switch actuated by a cam which is geared 2:1 to the frame metering cam. Through this pair of series switches a horizon recording camera shutter and a set of fiducial lamps are pulsed on alternate frames, i.e., each alternate frame will record a port and starboard horizon.



FUNCTIONAL BLOCK DIAGRAM OF OPERATING SEQUENCE

FIG. 31

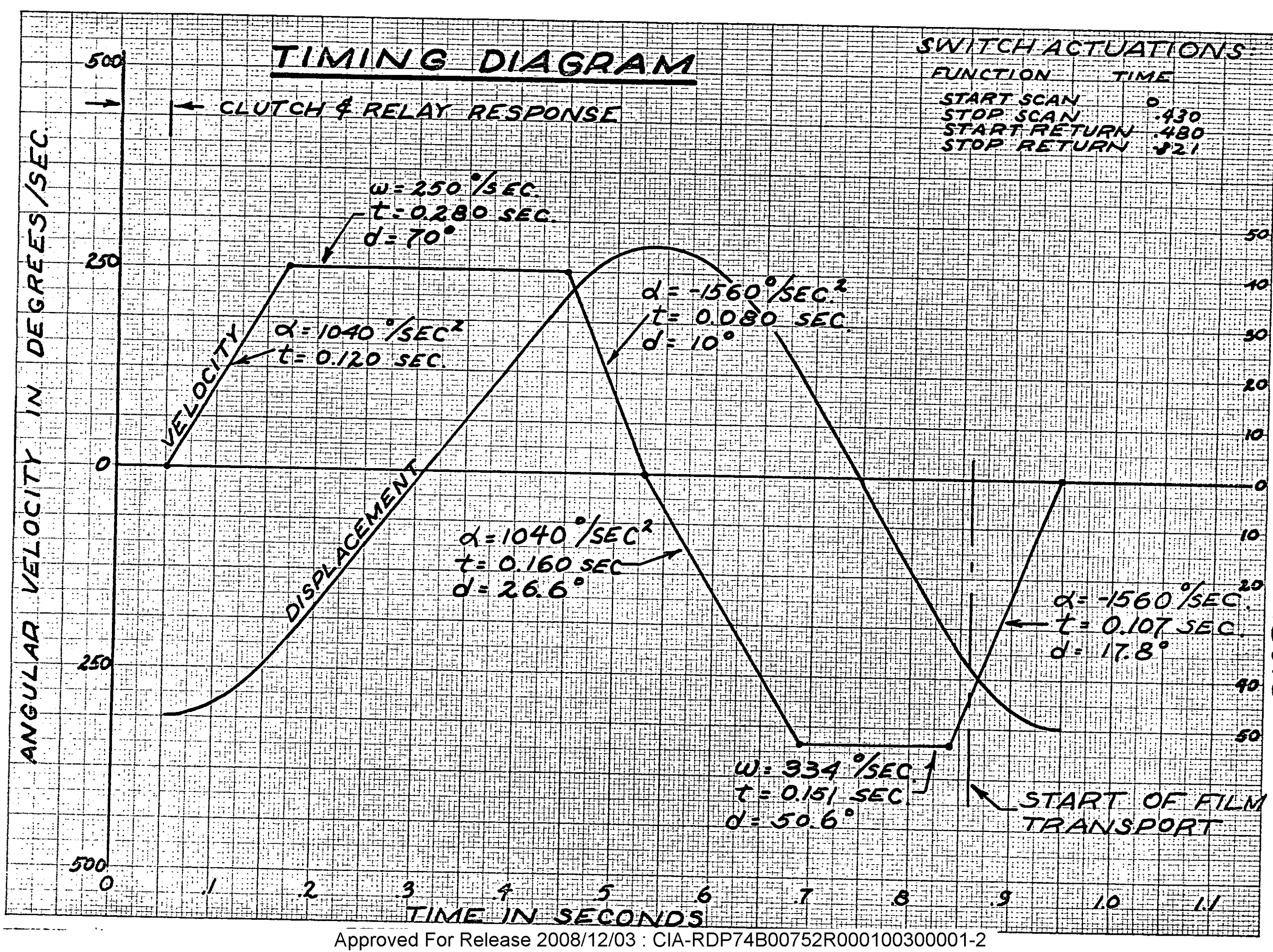

TIMING DIAGRAM
SWITCH ACTUATIONS:
FUNCTION TIME
START SCAN 0
STOP SCAN .430
START RETURN .480
STOP RETURN .821
CLUTCH & RELAY RESPONSE
ω = 250 °/SEC.
t = 0.280 SEC.
d = 70°
α = 1040 °/SEC²
t = 0.120 SEC.
α = -1560 °/SEC.²
t = 0.080 SEC.
d = 10°
α = 1040 °/SEC²
t = 0.160 SEC
d = 26.6°
α = -1560 °/SEC.
t = 0.107 SEC.
d = 17.8°
ω = 334 °/SEC
t = 0.151 SEC
d = 50.6°
START OF FILM TRANSPORT
VELOCITY
DISPLACEMENT
ANGULAR VELOCITY IN DEGREES/SEC.
DISPLACEMENT IN DEGREES
TIME IN SECONDS
500
250
0
250
500
50
40
30
20
10
0
10
20
30
40
50
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1

FIG. 32